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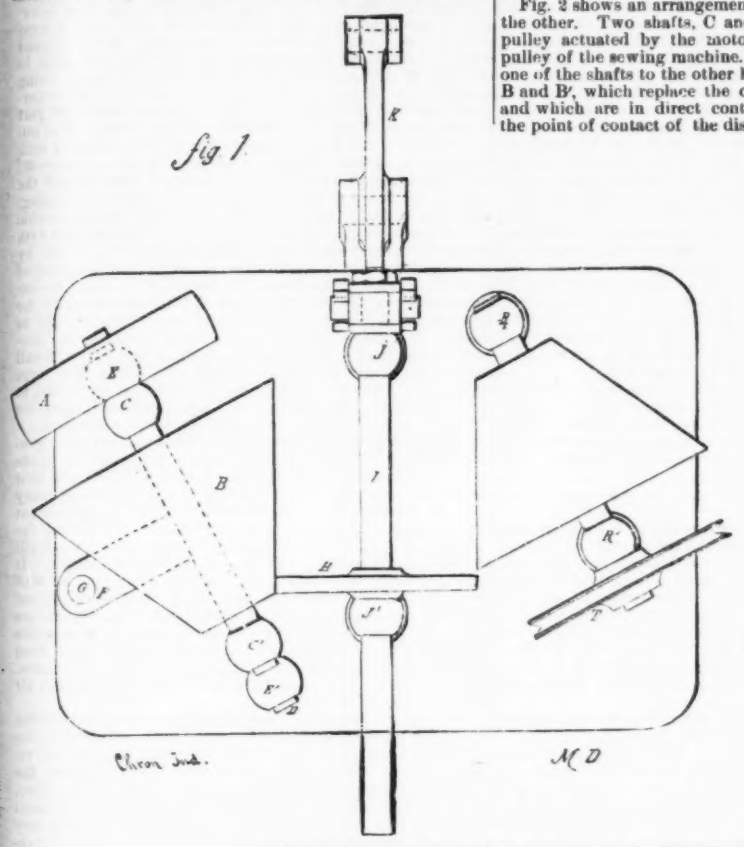
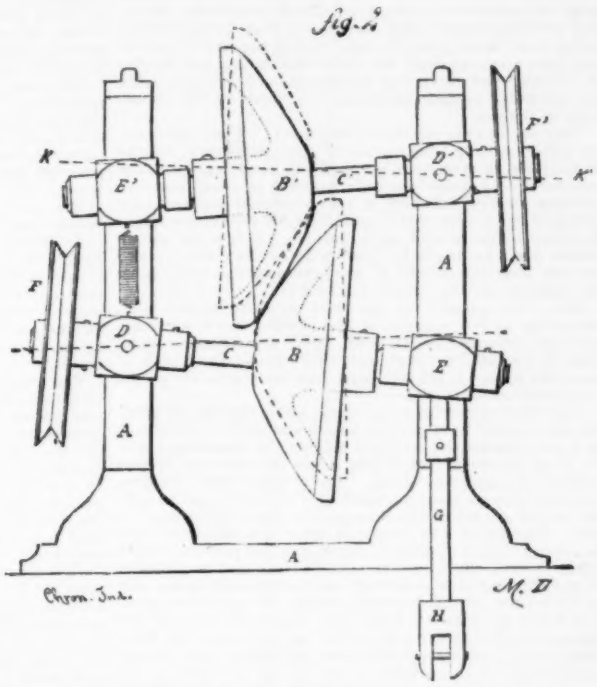
IMPROVED TRANSMITTING GEAR FOR VARIABLE VELOCITIES.

MR. JOSE DA SILVA SERTORI, of Rio de Janeiro, has invented an ingenious system of transmission, of variable velocity, for sewing machines and other purposes, so that any motor whatever may be used, and the action of the pedal be dispensed with. The apparatus is shown in plan in the accompanying Fig. 1. It consists of a cone, B, keyed to the shaft of the motive pulley, A, which receives the action of the motor directly. This shaft is carried by two columns, C and C', which are themselves fixed on a shaft capable of revolving on the terminals, E and E, so as to give the cone and pulley an oscillatory motion in a plane perpendicular to the plane passing through the axis of the columns. The latter are held in a vertical position by the spring, F, the pressure of which may be regulated at will. A second cone, Q, not quite so long as the first, is arranged parallel to the other, but in an opposite direction, as shown in the figure. The cone, Q, is keyed upon a shaft revolving in the heads of two stationary posts, and which carries at the same time a channeled pulley. This latter receives a driving cord designed to put the sewing machine in motion. Between the cones there is a disk, H, covered with rubber or gutta percha, which serves to transmit motion from cone B to cone Q through friction. The shaft, I, which carries the disk, H, slides longitudinally in the heads of the columns, J and J', by means of a gearing which transmits to it the action of a pedal. The pressure of the foot upon the latter brings the disk in contact either with the apex of the driving cone, B, and the base of the driven cone, Q, if slight speed is required, or with the base of B and the apex of Q if great velocity be needed. The intermediate positions of the disk correspond to medium velocities. The property of oscillating that the driving cone possesses has for its object the giving of a certain elasticity to its contact with the disk, and of facilitating the taking apart and putting together of the parts.

Fig. 2 shows an arrangement which is only a variation of the other. Two shafts, C and C', carry, one of them, the pulley actuated by the motor, and the other the driving pulley of the sewing machine. Motion is transmitted from one of the shafts to the other by means of two convex disks, B and B', which replace the cones whose form they recall, and which are in direct contact. The speed varies when the point of contact of the disks is made to vary, and this variation is effected by causing the two shafts to oscillate around one of their extremities. Of the four bearings that support the shafts, two, in fact, are fixed and pivot simply on the points, D and D', while the two others move as slides.—*Chronique Industrielle.*





IMPROVED TRANSMITTING PULLEYS FOR VARIABLE VELOCITIES.

SUPPRESSION OF THE DEAD CENTER IN CRANK SHAFTS.

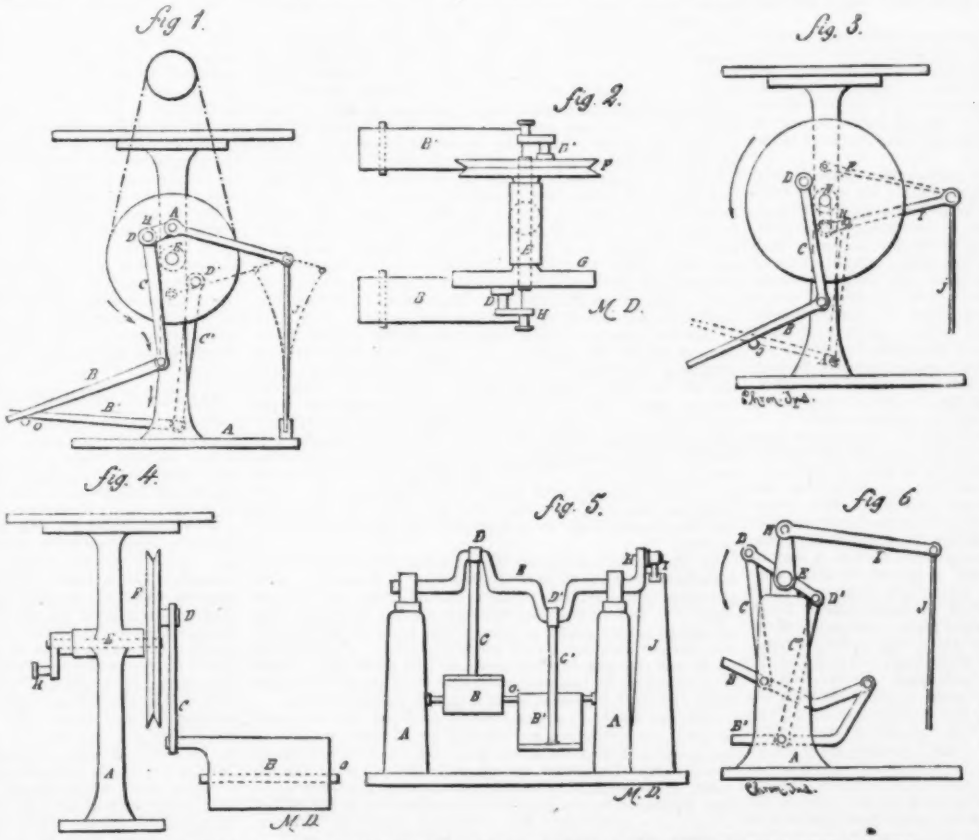
WE illustrate herewith a new invention due to M. Raffard, and which appears to be capable of numerous applications. It consists of a special kinematic combination applicable to all single-crank shafts or to cranks in the prolongation of one another, and preferably to shafts of small power, such as those of sewing machines.

Figs. 1 and 2 show the application of the system to a shaft, E, with two cranks, D and D', one in the prolongation of the other, and each moved by a connecting rod and pedal. The inventor adds to this mechanism a small winch, H, which is affixed to the crank pins, D D', and a connecting rod, which is articulated at one extremity with the winch and at the other with the extremity of a spring, J. All the parts being in equilibrium, as shown in Fig. 1, it will be seen that if the pedal, B', be pressed in the direction shown by the arrows, the motion of the pin, D', will diminish in measure as the tension of the screw, J, increases. Owing to this fact, there will be a resistance against the motion being effected in a direction contrary to the normal one. On the other hand, if pedal, B, be pressed, the motion of the pin, D, will increase at the same time as the tension of the spring, and motion in the direction of the arrows will be easily effected.

It will be seen that, in the position figured, as well as in all other positions of the crank pins, no dead center exists, and that, owing to this, much ease and regularity is given to the motion.

Figs. 3 and 4 represent the application of the same system to a single-crank shaft moved by a single rod and a single pedal.

Finally, in Figs. 5 and 6, the mechanism is shown applied to two cranks, one in the prolongation of the other.—*Chronique Industrielle.*



DEVICES FOR SUPPRESSION OF DEAD CENTER IN CRANKS.

IT is estimated that the total wool clip of the United States this year will aggregate 300,000,000 lb., worth $100,000,000.

GAS BURNERS.*

By WILLIAM SUGG, A.I.C.E.

COAL gas, as now supplied to the public, consists of hydrogen and marsh gas to the extent of about 80 per cent., and the remainder consists of luminous hydrocarbons of various qualities, with traces of sulphur in the form of disulphide.

The gas supply of London is watched over by a Commission, appointed by the Board of Trade, called gas referees, who are Professor Tyndall, Professor Vernon Harcourt, and Mr. Pole. They are empowered to prescribe the manner of verifying the illuminating power and purity of the gas, and they have also authority to act in cases of dispute in public lighting. Their prescriptions, as emanating from the only legal body of the kind in the kingdom, are accepted as the proper methods, so that in effect, though they are appointed in London, they may be said to be gas referees for the whole kingdom. But the use that is made of gas is a matter which is altogether out of the control of gas companies and their engineers, and here the proverb about food and bad cooks may be paraphrased. The great hinderance to the improvements in the use of gas has been the general public themselves, who have not taken sufficient interest in the kinds of apparatus employed, but have, as a rule, supplied themselves with the cheapest burners, stoves, and other apparatus, utterly regardless of the waste and annoyance which this system entailed; and when they have complained, they have always attributed the causes of failure to the quality or pressure of the gas, instead of ascribing it to the true cause.

In 1871, the gas referees made an examination of a number of gas-burners which they had collected from various large establishments, newspaper offices, warehouses, shops, and dwelling-houses, and they found that those burners (samples of those generally employed by the public) would only give about one-half the light that the gas was capable of yielding per cubic foot consumed, and several of the burners tested by them gave only one-fourth of the proper light of the gas.

They say in their report to Parliament: "The economy to the public, arising from the use of good gas-burners instead of bad ones, is so obvious as hardly to need remark. The gas-rental of London amounts annually to more than two millions sterling. Taking a very moderate estimate, upwards of one-fourth of this sum (£500,000 per annum) might be saved by the use of good burners. This is the saving which might be made in London alone; how much vaster the sum thus economized if good gas-burners were to come into general use throughout England."

Now, the quantity of gas used in London last year, according to the analysis of the London Gas Companies' accounts, prepared by Mr. John Field, was, in round numbers, 20,230,000,000 cubic feet, which is equal to a bulk of one mile square × 726 feet high, and its cost to the public was £2,911,000.

The result of careful trials, made with a number of burners taken lately from private houses and shops, shows that, as a rule, the amount of light obtained by the general public, from five cubic feet of gas, is less than one-half of that which it is capable of giving. The iron and metal burners, of which a great many are used, give the best result in light when they are worn out, although the shape of the flame is bad. The reason why, is that in order to obtain from what is a compound of hydrogen, marsh gas, and carbon, its best effect in light, the burner must be so made that the quantity of gas required to be consumed is proportionate to the size of the burner, so that it cannot exceed the maximum quantity which the burner is made for. Then the outlet of the burner itself, whether it be of the Argand or the flat-flame form, must be so arranged that the gas issues forth at a sufficiently low rate of velocity, so that it has time to get heated to a proper degree by the hydrogen and marsh gas before it comes into combustion with the oxygen of the atmosphere. When this rate of velocity is obtained in an Argand burner, the pressure at the point of ignition is almost *nil*. In flat-flame burners the pressure of the gas must be raised to a point sufficient to blow out the flame to a fan-like shape, but it must only be sufficient to do this if it is desired to obtain a good result per cubic foot of gas consumed.

One more point is of great importance in the construction of a gas burner—that is, that the gas should not be heated until it arrives at the point of ignition. The body of the chamber below the point of ignition must therefore be made of material which is a bad conductor of heat; so as not only to prevent the undue expansion of the gas before it arrives at the point of ignition, but also to maintain the heat in the flame.

Sir Frederick Bramwell very ingeniously pointed out, some time since, that the important point in the proper combustion of gas is not so much to keep the gas cool as to keep the flame hot. The distinction is extremely subtle; but, nevertheless, a non-conducting gas-chamber performs both these important functions. If a gas-chamber made of metal or any good conductor of heat is used, then the gas becomes expanded in bulk, and the velocity of the issuing gas is greatly increased; less time being given for chemical combinations necessary to produce a proper amount of light from it. In addition to this, as Sir Frederick Bramwell has pointed out, the heat which should remain in the flame is conducted away from it into the lower fittings of the burner, where it may burn the fingers of the incautious consumer, but it is of no manner of use in the evolution of light.

You will, perhaps, say it is not possible to conceive how the flame can be kept hot without keeping the gas cool at the same time, because if the heat is to be kept in the flame, and not conducted away down the stem of the burner, the gas must be kept cool by the means employed. But, nevertheless, there is a difference in the effects produced, and the ingenious definition of Sir Frederick is scientifically accurate. As an explanation of the expansion theory, it may be stated that if one cubic foot of gas is heated to about 500° Fahrenheit, it will occupy the same bulk that two cubic feet do at the mean temperature of the atmosphere. Now, supposing it is issuing in a cool state from the aperture of the burner at a velocity equal to one and a half miles per hour, it must then issue at the rate of three miles per hour, if the rate of consumption is equal in both cases. Therefore it has only half the time in the heated state to combine with the oxygen of the air that it had in the cooler state, and a loss of illuminating power is the result. Again, as regards the maintenance of the heat in the flame: supposing the chamber from which the gas issues is a conductor of heat. In this case the heat from the flame is conducted away from it down the stem of the burner, expanding the gas and leaving the flame so relatively cooled as to require more gas to raise it to the necessary state of incandescence to allow the oxygen to combine with it in the proper proportions. In this case, as the two operations are simultaneous, it is difficult to apportion the effect produced. But that the effect is produced is proved by the following experiments, made some time since by the late Mr. F. J. Evans.

Two Argand burners were made precisely alike in every respect, except that one had a combustion chamber made in steatite, and the other in brass. The same quantity of gas was consumed through both of these, the result being that the burner with the non-conducting chamber gave more light per five cubic feet of gas consumed than the other, the proportion being as fifteen candles to thirteen. The burner with a non-conducting chamber was quite cool immediately below the chamber, while the other was so hot that it could not be touched without burning the hand. The metal burners which are now used in enormous quantities in London and the provinces become exceedingly hot, so much so as to communicate the heat to a considerable distance down the fittings. The velocity of the issue of five cubic feet per hour of gas from these burners varies from ten to sixty miles an hour. The worn-out burners generally give the lowest velocity. As a rule, the metal burners give the lowest result in light per cubic foot of gas consumed.

For example, a metal burner of the flat-flame type, which has been stated in the columns of the *Journal of Gas Lighting* to be identical with the steatite hollow-top burner, invented in 1868, gives the following results: A large-sized burner, No. 8, burning five cubic feet per hour, gave a result equal to 11·5 candles, while the result obtained with a like quantity of gas from a steatite burner of corresponding size, which has a non-conducting gas chamber, was 14·6 candles, a difference in favor of the steatite of 3·1 candles, or nearly twenty-five per cent. more light. Another metal burner, of a size more generally in use by the public, only gave 6·2 candles for the five cubic feet, or considerably less than half the latent value of the gas, which was 16 candles.

The fact of the difference of illuminating power, with like quantities of gas, clearly shows that the two burners are not the same by any means. The statement gravely made in the columns of the *Journal of Gas Lighting* that they are identically the same, clearly shows that if this is the belief of the gas trade generally with respect to these two burners, it is no wonder that the public, who rely on the recommendations of the trade, continue still to waste their gas in the manner pointed out by the gas referees in 1870 and 1871.

As before stated, careful tests of a collection of burners, bought from different gas-fitters and ironmongers in various towns in England, and from their recommendation, prove that the knowledge of the proper use of gas possessed by these persons is still most incomplete, and, therefore, the general public continue still to burn gas in the same wasteful manner as they did when the gas referees made their report.

The remedy for this enormous waste of gas is in the hands of the public only. Gas producers, whether they are corporate bodies or public companies, are almost powerless to oppose the vested interest which derives large profits from the sale of gas-burners constructed with a view to require frequent renewals. It is only fair to say that the producers of gas have always shown the greatest interest in the improved use of gas in every way; but the speculating builder and his colleague, the local plumber and gas-fitter, hold a final power for evil over the employment of gas, which, till very lately, has been paramount.

Happily for the gas interest, the general public are beginning to take a deep interest in gas, and are acquiring a great amount of information concerning it, through the numerous gas exhibitions which have been held under the auspices of gas companies and corporate gas committees throughout the kingdom, and it is to be hoped that the forthcoming exhibition at the Crystal Palace, in October next, will very largely aid the good work of instructing the public how to use gas to the best advantage. Thus we may hope that soon the ring of interest inimical to the progress of gas will be broken through, and fresh encouragement given to the inventors of improvements in the use of gas. It will be impossible, in the limits of this paper, to give you a complete idea of all the improvements which have been, and are still being made; but I propose to indicate the direction they are taking, and give you a general idea of what they are.

It has been found that a comparatively large quantity of gas, about four to six times that ordinarily used, will give a much better result from one burner per cubic foot of gas consumed than can be obtained from four or six separate burners consuming the aggregate quantity of gas equal to that consumed by the large one; and this is true of both Argand and flat-flame burners. This is by no means a new idea; it was known to Faraday and others before him. I have in my possession an old burner made many years ago; it has several rings and a silver top drilled with very fine holes. The quantity of gas used is large—the effect is small—in fact, it is more useful for boiling water than for giving light. But this old burner is a type of a large Argand of twenty or thirty years ago. They did not succeed, because although they produce a great amount of light, it was at the cost of too much gas. Modern Argands will produce just double the amount of light for the same quantity of gas.

There is also incorporated in some of the newest burners now before the public an idea which was originated by Professor Frankland more than ten years ago, viz., that if the air for combustion supplied to a burner be heated before it arrives at the point of ignition, a much better result per cubic foot of gas consumed can be realized. This you will perceive is a mode of carrying out Sir Frederick Bramwell's idea of keeping the flame hot, and undoubtedly a better result can be obtained. This burner, although it did not come much into use, has very lately been repeated, and is now being sold on the Continent. The burner is so much like Dr. Frankland's that there is no difficulty in recognizing it at once.

Of the modern Argands, there are now several kinds; one is made with two or three concentric rings of flame and a glass chimney, and is made with non-conducting steatite gas chambers, and apertures permitting the gas to issue under an almost inappreciable pressure at the point of ignition, the velocity per hour being only about 1½ miles. In this kind of burner the gas is kept cool and the flame hot. These were first used in the public lighting of Waterloo Road; in 1879, and in Waterloo Place and Queen Victoria Street.

Another kind, of newer type, is made on the theory of keeping the flame hot by making use of the products of combustion to heat the air supply. This also combines the low velocity of emission theory, and likewise heats the gas itself. It is made by inverting the flame of the burner, the heat generated by the products of combustion being carried away by a concentric flue, fastened round the burner, through which metallic tubes convey the air necessary to produce combustion, which thus becomes heated.

A third is constructed on the principle of keeping the flame hot and the gas cool, but has besides an arrangement for admitting separate currents of cold air round the flame, for the purpose of keeping the chimney cool. It was important to observe that, although this burner does not warm the air admitted to it for promoting combustion, yet the results per cubic foot of gas consumed are stated to be as high as any of the others; showing clearly that there is no advantage in heating the gas before combustion. As to the advantage obtained by heating the air, the practical effect upon an Argand suitable for use by such ordinary unskilled labor as is usually employed to look after gaslights, has not yet been clearly demonstrated; although it is without doubt a great advantage to burners of the flat-flame type because these have always too much cold air supplied to them.

The Argand, with its more complete regulation of air and its immunity from the effect of surrounding cold air, is able to evolve from 15 to 30 per cent. more light per cubic foot of gas consumed than can be obtained from the best flat-flame burner; but, although the general public have no objection to glass chimneys in paraffin, and other oil lamps, they do not appear to look with favor upon the general employment of glass chimneys for gas burners, no matter how much better the result to be obtained. I need not say that the cordial support of the ring inimical to the true interests of gas is given to the public on this point, and a great deal of very strong literature condemnatory of the Argand burners has been widely disseminated. But it is impossible, in the face of the improvements which are continually being made in gas burners of the Argand type, to believe otherwise than that they are destined to play an important part in the gas lighting arrangements of the future. The improvements in flat flame burners, though not producing such high results as those obtained from large Argands, are great, and, concurrently with improved lanterns, have placed the lighting of the public streets on a much improved footing. Here, again, about three times the amount of light per cubic foot of gas is obtained from the use of large burners than with the old fashioned small ones. The consumption of gas by the large ones is only equal to the aggregate consumption of four or six smaller burners. In addition to this, the improvements in the reflecting tops of the lanterns make the new lamps still more effective, and may fairly be said to double the effective power. In internal lighting, the progress of gas has been very considerable of late years. Small burners for rooms have been greatly improved. For large rooms and theaters new kinds of sun burners are made, to give three times the amount of light obtainable from the old ones, and to ventilate the buildings at the same time.

One of the greatest advantages of gas is that the heat generated by the combustion can, if properly applied, be made to do the work of ventilation, and it is in this direction that the future progress of gas lighting lies. There are many ways of utilizing this heat; some are extremely easy to put into practice, others require more preparation. Among the simplest, is the method of ventilating rooms by the fish-gill ventilator, invented by the late Goldsworthy Gurney. It consists simply in covering an opening made in the wall with strips of calico fastened across the hole by tacks put into the two upper corners of each band. The bands are made just long enough for the lower part of the superior band to cover the top part of the inferior one. When fixed properly, they open like the gill of a fish, hence the name. They can be used to let in fresh air, or carry off heated air from the top of a room.

These useful and simple ventilators, if employed in rooms where gas is used, would tend greatly to the comfort of the public who require a good light, but complain of the resulting heat. They work when closed by diffusion, the heated air passing through the porous medium of the calico, and the cooler air from outside the rooms passing in without draught. For the ventilation of ballrooms it is very easy to put into the windows a frame fitted with muslin or washed calico of half or even the full size of the window. Ventilation will thus take place by diffusion, and the draughts and danger resulting from incautiously opened windows will be avoided. If the wind blows hard on this opening it may be protected by a loose curtain of muslin or calico hanging in front of it.

You will perceive, therefore, from what I have said, that the progress of invention in gas lighting is great and continuous, and that in the future, if the public will only interest themselves just sufficiently to obtain a moderate amount of information on the subject of gas, they will be enabled to use it with great economy and comfort to themselves in every way. The facile manner in which gas can be employed to produce the light of a rushlight or the blaze of a thousand candles by the mere turn of the wrist, joined to the readiness with which it can be conveyed to great distances without any practical loss, will always insure a large and growing demand for it everywhere.

But it must be remembered that its extreme adaptability renders it capable of being used with the most crude apparatus as well as the most perfect; and when we see in the public streets the blazing pipe and shovel, a rough but powerful burner of from 100 to 600 candles power, rigged up in a few minutes by a navvy, we must not be surprised at the prevalence of crude apparatus of smaller dimensions put into practice by the public, who are not aware that they can do better with a more perfect burner.

* Abstracted from a paper read before the Mechanical Section of the British Association, at Southampton.

MARTIN & DU TREMBLAY'S VACUUM BRAKE.

THERE are two systems of brakes in use on the French railways, the Westinghouse compressed air and the Smith & Hardy vacuum brake. The latter is employed by the Company of the North, and has been applied in numerous instances on English and American roads. For the purpose we have in view, it may be described succinctly as follows:

There is a tubing which runs along under each of the cars of a passenger train, and under each car there is fixed an iron plate cylinder which communicates with the general conduit. This cylinder contains a flexible membrane, held between two thin metallic plates. When a vacuum is created in the conduit, the membrane in the cylinder rises with the piston under the effectof atmospheric pressure, and the piston then acts on the brake block through the intermedium of levers whose operation is shown in the accompanying figures. The vacuum is produced instantaneously in the general conduit, and in the cylinder under each car, by the engineman sending a jet of steam into a cone. The velocity of the steam carries along the air, and produces a vacuum and an almost instantaneous locking of all the wheels of the cars. Such is the Smith & Hardy system. Now, we are far from accusing these honorable engineers of copying an invention that it may be that they did not know the existence of; but the similarity of their system to that of M. Martin, whose patents extend back to March 10, 1860, is worth nothing, since the poor inventor, at present forgotten and in a situa-

tion of misfortune, has scarcely profited from it. It will be seen from the accompanying figures, that, in the Martin system, there is also a receptacle containing a flexible membrane which rises when a vacuum is created, and that a piston follows it and acts upon the brake blocks through the intermedium of levers. And, singularly enough, the similarity extends further. On the 4th of April, 1877, Messrs. Smith & Hardy took out a patent for a method of creating a vacuum by means of an emission of steam from the boiler, the said steam entering a cone placed in an enlargement of the pipe from which the air is to be removed, as shown in

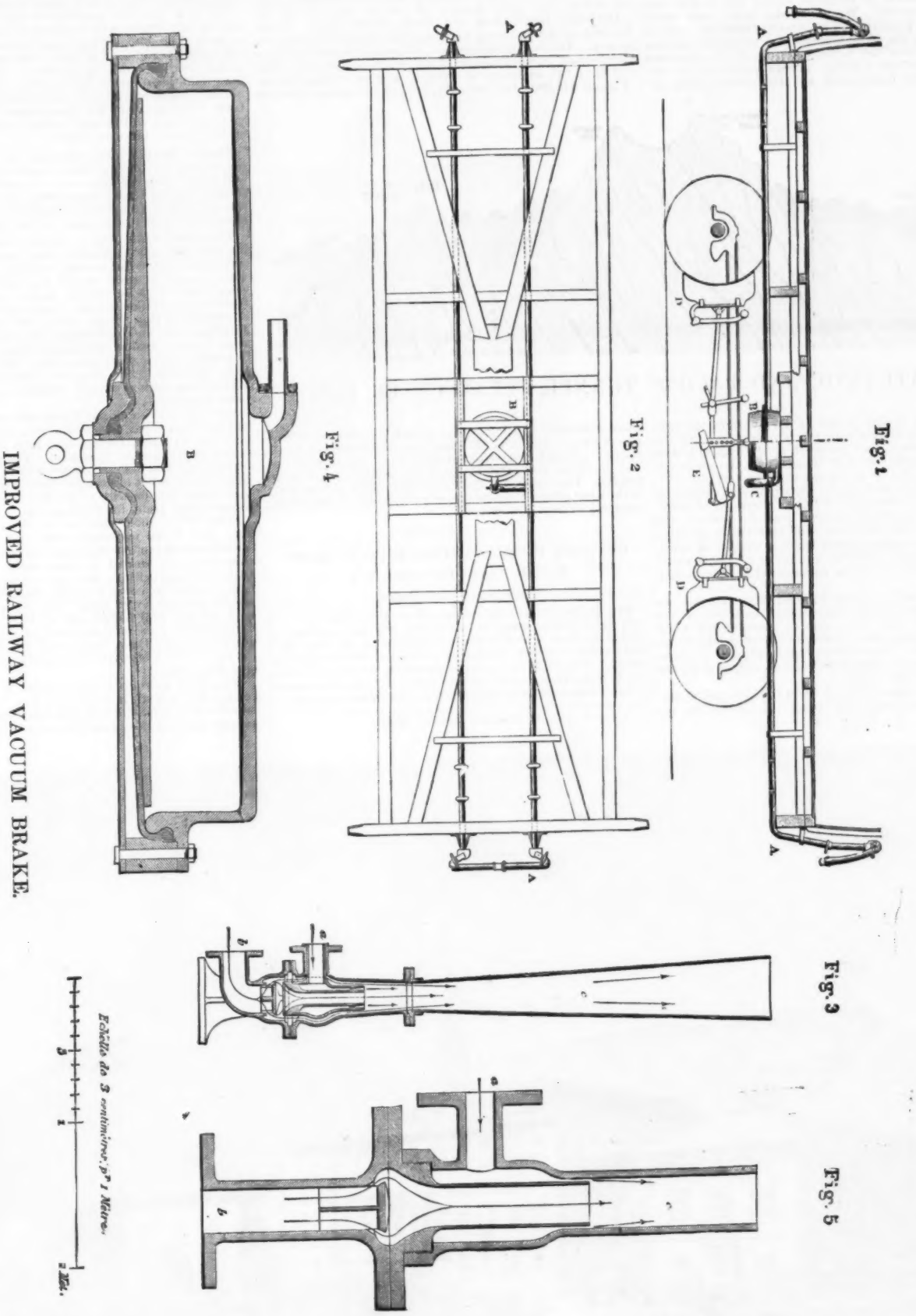


Fig. 3. This device has been named an "ejector." But *seventeen years* previous to this Messrs. Martin & Du Tremblay (December 27, 1860) took out a patent for an improvement, in which a jet of steam was substituted for the pumps that were insufficient to produce a vacuum.

The Railway Company of the East received the offer of Messrs Martin & Du Tremblay in 1862, to perform the experiment on a large scale, and put at their disposal for the purpose a locomotive and tender. This experiment replaced those that had been made for six months with very small models at the Palace of Industry. But how is it, it will be asked, that experiments so well begun, and founded upon a principle applied at present by twenty or thirty companies in foreign countries, were abandoned on the above-named road? To answer this, we must remember the epoch at which they were made—twenty years ago. There was not retired from the contest. This, however, is, perhaps, the history of many inventors.

The following is a description of the cuts, in which the two inventions are compared:

Smith & Hardy's Vacuum Brake.—Fig. 1, elevation of the system, with section. Fig. 2, plan; A A, general conduit; B, vacuum cylinder connected with A A by means of the tube, C; D D, brake blocks acted upon by the cylinder, B, through the intermedium of the lever, E. Fig. 3, section of the ejector; *a*, steam inlet; *b*, air inlet; *c*, tube for escape of air and steam into the atmosphere.

Martin & Du Tremblay's Vacuum Brake.—Fig. 4, section of the vacuum cylinder; A, general conduit; B, vacuum cylinder; Fig. 5, section of the ejector; *a*, steam inlet; *b*, air inlet; *c*, tube for escape of air and steam.—*Bulletin de la Soc. d'Encouragement.*

A NEW MINING TUNNEL.

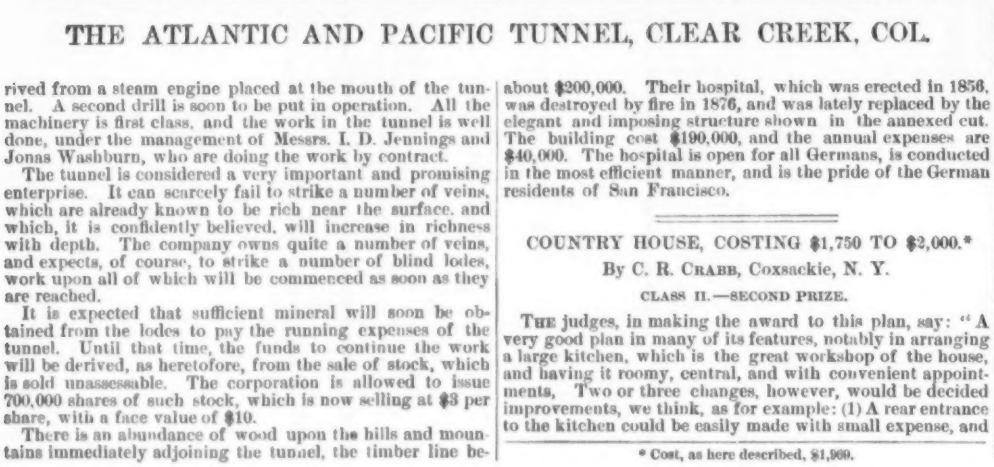
WE give herewith a sectional view of an important mining tunnel now in process of construction in Clear Creek county, Colorado. Work upon this tunnel was commenced in the summer of 1880, by a company known as the Atlantic-Pacific Tunnel Company, of which M. M. Pomeroy, of Denver, is President. As its name implies, this tunnel is designed to pierce the summit of the Rocky Mountain divide; to accomplish which, at the level started, will require a length of 25,200 feet. The design of the enterprise is to open up at great depth, certain mines which are worked upon the surface, and which, it is believed, will be found to continue and increase in value to a depth even far below that at which they will be intersected by the tunnel.

The eastern end of the tunnel commences at the foot of Kelso Mountain, which, with Torrey's and Grey's Peaks, forms, at this point, the backbone of the Rocky Mountain divide. The locality is about sixty miles due east from the city of Denver. There is a railroad now running within ten miles of the east end of the tunnel, with a graded track to a point some eight miles nearer, at which point it bears off to the westward and crosses the divide through Loveland Pass, as shown in our illustration. After crossing the divide, it follows along the western slope of the mountain and approaches about as near to the western terminus of the tunnel as we have already shown it does to the eastern. This

tunnel, when complete, will have the very best facilities for transporting its output of ore or bullion.

The tunnel will pass nearly under the center of Grey's peak, at which point it will reach its greatest distance from the surface—8,425 feet. The elevation of the various peaks above the level of the sea is given in the diagram. The first silver discovery in Colorado was made near Kelso mountain and not far from the eastern terminus of this tunnel. The first important gold discoveries were made near Idaho Springs, in the summer of 1858, and along the line of the railroad already referred to.

The eastern end of the Atlantic-Pacific Tunnel has now been extended about 1,500 feet. It is 10 feet wide by 9 feet high. No timbering is required except for a few feet at the commencement. Work has also been commenced for its western terminus. The waters from the eastern entrance flow to the Mississippi; those from the western find their way into the Colorado. Work is continued night and day without ceasing. An Ingersoll drill is employed, driven by compressed air, the power being derived from a steam engine placed at the mouth of the tunnel. A second drill is soon to be put in operation. All the machinery is first class, and the work in the tunnel is well done, under the management of Messrs. I. D. Jennings and Jonas Washburn, who are doing the work by contract.



THE ATLANTIC AND PACIFIC TUNNEL, CLEAR CREEK, COL.

The tunnel is considered a very important and promising enterprise. It can scarcely fail to strike a number of veins, which are already known to be rich near the surface, and which, it is confidently believed, will increase in richness with depth. The company owns quite a number of veins, and expects, of course, to strike a number of blind lodes, work upon all of which will be commenced as soon as they are reached.

It is expected that sufficient mineral will soon be obtained from the lodes to pay the running expenses of the tunnel. Until that time, the funds to continue the work will be derived, as heretofore, from the sale of stock, which is sold unassessable. The corporation is allowed to issue 700,000 shares of such stock, which is now selling at $3 per share, with a face value of $10.

There is an abundance of wood upon the hills and mountains immediately adjoining the tunnel, the timber line being in full sight, however, less than 1,000 feet above. A fine and never failing stream of water passes directly by the mouth of the tunnel, about 200 feet below it. This may be considered as one of the most important mining enterprises yet undertaken in the State, and when completed will be the longest mining tunnel on the continent.—*Mining and Scientific Press.*

THE NEW GERMAN HOSPITAL, SAN FRANCISCO, CAL.

THE Germans residing in the United States have organized mutual protective societies in most of the large cities, the eldest and most known of which societies is the "Deutsche Gesellschaft der Stadt New York. Baron Steuben, of revolutionary fame, was the first president of this society. The next in rank is the "Allgemeine Unterstützungs Gesellschaft, in San Francisco," which was organized in 1854, and has 3,043 members at present, and an annual income of about $42,000. The property, etc., of the society is worth about $200,000. Their hospital, which was erected in 1856, was destroyed by fire in 1876, and was lately replaced by the elegant and imposing structure shown in the annexed cut. The building cost $190,000, and the annual expenses are $40,000. The hospital is open for all Germans, is conducted in the most efficient manner, and is the pride of the German residents of San Francisco.

COUNTRY HOUSE, COSTING $1,750 TO $2,000.*

By C. R. CRABB, Coxsackie, N. Y.

CLASS II.—SECOND PRIZE.

THE judges, in making the award to this plan, say: "A very good plan in many of its features, notably in arranging a large kitchen, which is the great workshop of the house, and having it roomy, central, and with convenient appointments. Two or three changes, however, would be decided improvements, we think, as for example: (1) A rear entrance to the kitchen could be easily made with small expense, and it would both save steps, and the carrying of various articles in and out through the 'stoop' door, which is exposed to view from the street. (2) Rearrange pantry and adjacent closets, to have a direct passage from kitchen to fuel-room, instead of going through two 'entry' doors. There is here the same objection as noted in the plan given in May, viz., that the bath room cannot be used by occupants of the second story, except by passing through the kitchen or sitting room, and then through the bedroom, when it may be occupied by persons sleeping there, or by an invalid. A bath room should always be placed where it can be freely entered by all the occupants of a house, without disturbing any one else; and also so as to be warmed in cold weather."

* Cost, as here described, $1,900.

We now give the descriptive text, or "specifications," sent by Mr. Crabb, with such condensations and suggestions as seem desirable. (These specifications not only describe the materials and kind of work, but also serve as a basis for giving out the work by contract. In a written contract, some additional items may well be stated, as the kind of blinds, quality of lead to be used in the tank, etc., etc. The book "House Plans for Everybody" supplies many suggestions which will be very useful to any one about to construct a house, large or small.)

Mason's Specifications.—Excavate for cellar under entire house, and for footing stones under veranda, wood house, and privy; also for drain and cesspool. If water can be found near, dig a well deep enough for a constant supply of water, about 6 feet from foundation, in rear of kitchen; stone it up 2½ feet in diameter in the clear.

Foundation walls to be 18 inches thick, and of good building stone, started in trenches 4 to 6 inches, according to the soil, below the cellar bottom, on base stones, if obtainable, wide enough to reach across the wall. Lay to line both sides, 3 feet high in cement mortar, and the remaining 3 feet 8 inches in lime mortar. Lay up cellar way with stone in cement mortar. Steps to be of cut stone, 12 inches wide, 3 inches thick, and 5 feet long. Use brick for risers. [Where stone is not accessible and cheaper than brick, the latter may be used for cellar walls, etc.—ED.] Build six *piers* of brick, 12 by 12 inches, where they are shown (Fig. 3), each capped with a stone the size of pier. Build a double pier for sitting room chimney.

Start the kitchen chimney from the cellar bottom, to have one flue from cellar, also a flue from kitchen fire-place, built for a No. 9 range. Use a 4 by 8 inch stone lintel, and slate hearth bedded and set in cement. Put a 6 inch tube in ventilating flue 4 inches above second story ceiling timbers, and all necessary tubes in draught flue. Build parlor chimney from cellar bottom with single flue. Make fire-place for a common iron grate, for wood or coal.

Start sitting room chimney on piers, carrying up single flue. Put in all necessary tubes and covers. Top out in cement mortar, and as shown on elevations. All piers and chimneys to be started on large stone, bedded in cement. Lath walls and ceilings, and also a space overhead in cellar, large enough to cover a swing shelf, with hemlock lath, breaking joints every sixth. Put on a heavy scratch coat with mortar, well haired, and at least a week old. Hard finish ceilings on scratch coat (broom scratch), in best manner with plaster Paris, white sand, and lime. Finish walls for paper with a brown coat of mortar and lime, skim troweled down hard.

Set a plain marblized slate mantel in parlor, and do necessary mason work in setting kitchen range. Lay the cellar drain with brick tile, and sink drain with 3 inch glazed tile, making joints perfect with cement, and scrape it smooth on

THE GERMAN HOSPITAL, SAN FRANCISCO, CAL.

inside. Tile to be laid on a 6 inch hemlock board, brought to a true and even grade. If the ground slopes well away from the house, make a shallow cesspool with stone, laid dry, extending and putting it not less than 200 feet from the well. If nearly level, build it of brick, well cemented inside. Cover with large flagstone, leaving a man-hole 22 inches in diameter. Make the cesspool 6 feet by 6 feet, and 8 feet deep. Set large flat stones below posts under veranda, wood house, and privy, each to have a place cut on upper face, to set an iron rod.

Leave house broom-clean, removing mason's materials and rubbish, and leaving mason work complete and finished.

Carpenter's Specifications.—First story to be 8 feet 6 inches in the clear, and second story 8 feet in clear. Posts 16 feet

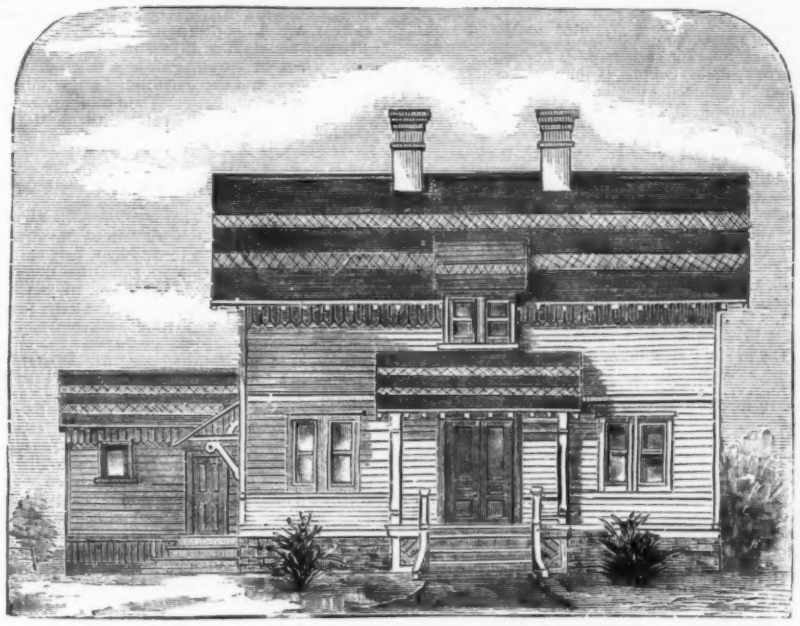


FIG. 1.—FRONT ELEVATION.

from top of sill to top of plate ceilings of upper room, to finish 10 inches on rafter. Sills for house, 6 by 8 inches; for wood house, 6 by 6 inches; for veranda, 4 by 6 inches.

Studding next to openings, 3 by 4 inches; intermediates, 2 by 4 inches. Corner posts, 4 by 6 inches. Plates, doubled, 2 by 4 inches. Rafters, 2 by 6 inches, 2 feet to center. Collar beams, 2 by 6 inches.

First story floor timber, 3 by 8 inches, 20 inches to center. Second story floor timber, 2 by 8 inches, set 16 inches to centers. Rafters and floor timbers to be spruce, the balance of the frame to be sound hemlock.

Frame the sills together with mortise and tenon, using 6 by 8 inch cross sills under partitions, as shown, set on edge. Frame in lower floor timbers flush with top of sill. Every other floor beam in second story, under tank, to be 6 by 8 inches; cap of partition, under tank, to be extra heavy, studded up with 2½ by 4 inches, 12 inches to centers. Studding in outside wall to be 3 by 4 inches, set 16 inches to

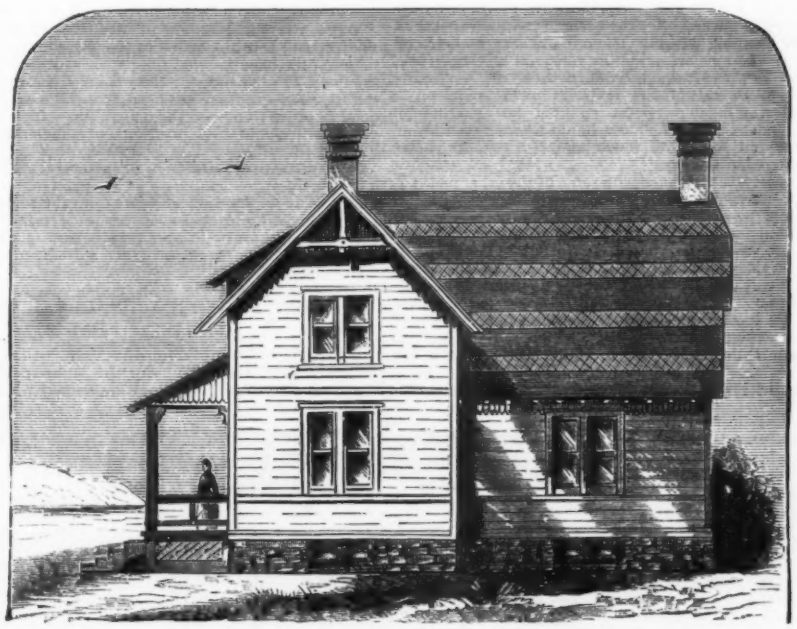


FIG. 2.—SIDE ELEVATION.

center, where weight of tank comes. Plane and cut the ends of rafters to pattern, as in Fig. 7, allowing them to project 20 inches over plate.

Sheathe the frame with hemlock boards, well fastened on with tenpenny nails, put on diagonally in gable ends. Roof, board with 1¼-inch matched pine plank, laid smooth side down, as far out as the roof projects, covering balance with 6 inch hemlock boards, or shingling strips; put in fourteen inch tin valleys, painted both sides, and shingle in the tin gutters, as in Fig. 8, and paint both sides of the tin. Straps across the gutters should be about two feet apart. Put in a line of gutters, graded to and a little above the tank. Use a 2-inch leader, put through roof, and within 5 inches of bottom of tank. Place the other gutter as near the edge of the roof as practicable. Put on leaders of proper size, to conduct water to tank and ground.

All shingles to be best sawed pine, 18 inches long, laid 5½ inches to the weather. Water-table to be 6 inches wide, 1¼ inch rabbeted. Corner boards to be 1¼ inch thick, and show 4 inches wide. All belts to be 1¼ inch thick, rabbeted for clapboards. Make window frames as shown, with plain drip caps, 1¼ inch casings, 1¼ inch jambs, and 2 inch sub-sills. Cut pockets, and put in axle pulleys for weights. The sash in mullion windows of first story, for glass 18 by 30 inches, 2-light. In second story, 18 by 28 inches, sash, 1¼ inch. The single frame windows of first story to have sash 18 by 30 inches, 4-light; and for second story, 18 by 28 inches, 4-light. All to be glazed with best quality French sheet-glass. Make other windows as shown on plans and elevation.

Prime paint the frames and corner boards before setting. Cover all sheathing with best resin-sized building paper, giving good lap, and have it extend well under all frames, casings, etc. Cover with half-inch bevel edge pine siding, 5½ inches wide, to lap not less than three-fourths of an inch, and nailed with sixpenny nails. All outside pine to be free from splits, sap, and loose knots.

Put wood house sills 6 inches from the graded ground, on inch iron rods, to have thread and nut on upper end to adjust sills; lower end to rest on stone set below frost. Roof and frame same as main. Side of wood house may be covered with 6 inch "novelty siding," instead of the bevel edge pine siding. Build privy the same. Build hood over kitchen door, as shown, Fig. 5. Make platform stoop, set on rods, with outside steps on two sides; plank for steps, 1¼ inch; for risers, seven-eighths inch thick. Set front porch on iron rods. Floor to be narrow 1¼ inch matched pine, driven up in paint. Steps, 1⅛ inch thick, and risers, ⅞ inch. Put up rail and seats where shown. Rafters, 2 by 5 inches, spruce, planed and cut to pattern. Roof boarded with matched pine plank, smooth side down. In shingling the roof, cut the two middle courses to pattern. Put on brackets, and do all ornamental work as shown.

Cover cellar-way with a pair of flap-doors, made of 1¼ inch matched pine plank, with proper hinges, etc. All the windows to have outside blinds, except those in cellar. Bridge all floor timbers, one row through each span, with 1½ by 2 inch spruce strips. Use 1¼ inch matched pine plank, 6 inches wide, for flooring, selecting the best for the kitchen, pantry, and bath-room. Set partition of 2 by 4 studding, 16 inches to centers, and double at openings. Make angles solid with blocks, spiked in.

Build stairs as shown, with 1¼ inch plank treads, and seven eighths inch risers, blocked and glued. Put up a 4 inch black walnut rail, 2 inch black walnut turned balusters, and 8 inch turned black walnut newel. House to be cased on first or scratch coat. All inside pine to be clear. Door and window casings 5 inches wide, seven-eighths inch thick, with a cove on each edge, and three scratch beads run through the center, as in Fig. 9; these to be cut against corner blocks, 5½ by 5½ by 1¼ inches, Fig. 10. Use base blocks for door, 5½ inches wide, 8½ inches high, 1¼ inch thick. Baseboards of first floor, 8 inches wide; second floor, 6 inches. Bevel off top edge, and run on bead, as in Fig. 11.

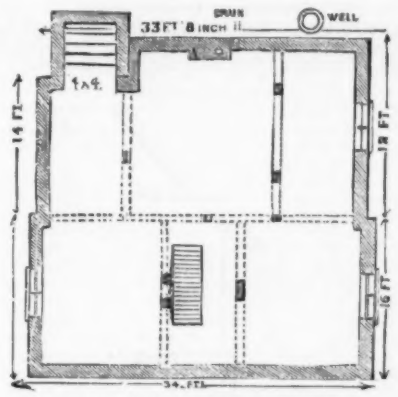


FIG. 3.—CELLAR OR BASEMENT.

Front doors to be each 2 inches thick, 2 feet 3 inches wide, and 7 feet 6 inches high; to have ground glass in upper panel. Furnish with flush bolts, lock, and Kahala trimmings; also a good lever bell, to cost $2.50. All doors on first floor to be four panel, moulded both sides, and 1⅛ inch thick; white porcelain trimmings; mortise locks, and hard-wood thresholds. Second floor to have four-panel "O. G." door, 1⅛ inch thick, mortise locks, brown trimmings, pine thresholds.

Put plain wood mantel in each chamber, and a neat hard-wood mantel in sitting room. Fit up closets with shelves, and

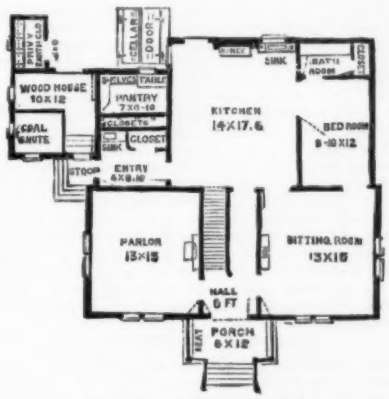


FIG. 4.—FIRST STORY.

a set of books 9 inches apart, on two sides. Build a tank in attic, of good 2-inch pine plank, 4 feet wide, 10 feet long, inside measure, and as high as the roof will permit, to be properly timbered and braced. Put half-inch iron rod across the top at center; cover top with seven-eighths inch matched boards, leaving a man-hole with cover. Make a ventilating tube of pine boards 6 by 6 inches, running from top of tank to top side of collar beams. Connect it with ventilating flue of chimney with a piece of 5-inch stove-pipe. Have the leader from gutter made loose joints, so that it can be taken off, and the tube plugged when no water is wanted in the tank.

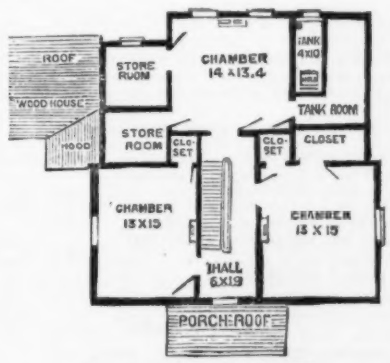


FIG. 5.—SECOND STORY.

Make scuttle and cover in ceiling of chamber over kitchen. Wainscot kitchen, entry, and bath room, 3 feet high, with narrow matched and beaded pine, five-eighths inch thick; cap with nosing and cover. Seal up sink, with door under, and put up splash-board 16 inches high. Fit up pantry with table, as shown, with drawers under; a set of closets with doors along one side, with closets for flour barrels under, and a set of open shelves. Build a closet in entry of matched pine boards, 3 by 5 feet. Put up a row of hooks. Fit and properly hang batten door to the same.

Build a wood sink where shown, 20 by 30 inches wide, by 5 inches deep. Ceil up under, making a closet with door. Put up board at right hand of sink for water-pail. Case up bath-tub with pine, putting up proper cant-boards, etc.

Build steps from stoop down in wood house. Make coal-bin, where shown, of hemlock boards, to hold 6 tons of coal. Make window and chute of proper height to shovel in coal from wagon. The back door of wood house to be 1¼ inch matched pine, and 3 feet wide, properly hung, with a bolt to fasten from inside.

Fit up privy with 1¼-inch counter top, to have hinged covers. Build reservoir in top for dry earth, part of which may extend in wood house. Place window so that earth can be shoveled in from a wagon. Make a tight box, with hard wood runners, and stout ring and staple in end, to receive droppings, so that this can be drawn away and emptied when necessary. Put up a swing shelf in cellar. Do all necessary carpenter work to carry out and complete the design of the entire building.

PLUMBER'S SPECIFICATIONS.

Put up in kitchen a thirty gallon galvanized iron boiler, set high enough to clear the sink. Furnish iron sink 20 by 30 inches. Furnish a 6-foot bath-tub, of 12-ounce sheet copper,

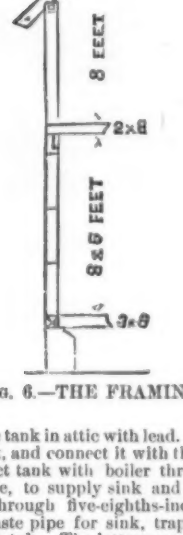


FIG. 6.—THE FRAMING.

well tinned. Line tank in attic with lead. Put a 3-inch lead waste pipe in tank, and connect it with the leader at corner of house. Connect tank with boiler through three-quarter inch "B" lead pipe, to supply sink and bath-tub with hot and cold water, through five-eighths-inch "B" lead-pipe. Put in 1½-inch waste pipe for sink, trapped, and 1¼-inch waste pipe for bath-tub. The latter may connect with sink waste pipe above the trap. Properly connect waste pipes with the drain.

Connect boiler with water back of range. Put a 1¼ inch lead waste pipe in sink in entry to go through wall and discharge on the ground; no service pipe required for this sink. Put up in the kitchen, at right hand of sink, a No. 2 "union pump," or its equivalent; connect it with the well by a 1¼-inch galvanized iron pipe. [An important matter is not stated. The pump to be "suction" and "force" with strong pipe up to tank, and "tell-tale pipe" down to sink—to fill tank from the well (or from cistern) when roof supply fails.—EDS.]

PAINTER'S SPECIFICATIONS.

Prime outside of house and the blinds with white lead, oil, and yellow ocher. Cover this with one coat best white lead and oil. Paint in colors to suit the owner. Paint all

FIG. 9.

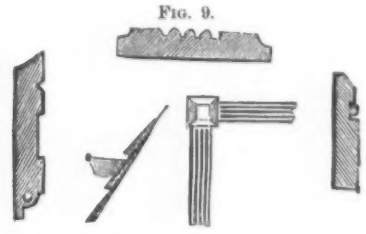


FIG. 7. FIG. 8. FIG. 10. FIG. 11.

inside work two coats, using best materials, and in tints to suit those concerned. Shellac knots, and putty all nail-holes and splits. Oil and shellac the newel, post, rail, and balusters.

ESTIMATE OF WORK, MATERIALS, ETC.

Digging cellar and drain	$30.00
Well, complete	30.00
52 yards stone work at $2.25	117.00
10,000 brick for chimneys and piers at $10.00, laid,	100.00
Drain, $32.00; stone cesspool, $14.00	46.00
576 yards lath and plaster, at 25 cents	144.00
Stone steps	3.00
Slate mantel and grate	28.00
	$498.00

Hemlock Timber.

Sills, 6 by 8 in. 238 feet in length	952 ft.	
2 sills, tank, 6 by 8 in. by 18 ft. long,	144 ft.	
25 collar beams, 2 by 6 in. by 14 ft. long	350 ft.	
7 posts, 4 by 6 in. by 16 ft. long	224 ft.	
6 wood-house sills, 4 by 6 in. by 13 ft long	136 ft.	
80 studs, 2 by 4 in. by 16 ft. long	887 ft.	
20 studs, 3 by 4 in. by 16 ft. long	320 ft.	
18 rafters on kitchen, 2 by 6 in. by 12 feet	216 ft.	
	3,229 ft. at $17.00,	54.89
150 wall strips, 13 ft long, at 14 cents		21.00
50 joists, 2½ by 4 in. 13 ft. long, at 18 cents		3.00
150 roof boards, 6 in. 13 ft. long (hemlock culls), at 8 cents		12.00
325 sheathing, 10 in. wide, 13 ft. long, at 15 cents		33.75

Spruce Timber.

34 floor timbers, 3 by 8 in. by 16 ft. long	1,088 ft.	
40 floor timbers, 2 by 8 in. by 16 ft. long	840 ft.	
40 rafters, 2 by 6 in. by 14 ft. long,	560 ft.	
	2,488 ft. at $22.00,	54.74
18,000 best pine shingles, at $4.75		85.50
160 lb. sheathing paper, at 5 cents		8.00
600 ft. 1¼-inch pine, for frames and casings at 4 cents		24.00
400 ft. 1¼-inch inside frames and casings, at 4 cts.,		16.00
2,500 ft. clapboards, at $24.00 per M.		60.00
86 "novelty siding," 6 in. wide, at 16 cents		12.76
320 matched pine planks, 1¼ by 6½ in. at 20 cts. each		64.00
Stairs, rail and newel, complete		38.00
1,000 ft. ⅞ inch pine for casings, at 4½ cents		45.00
480 ft. narrow beaded ceiling, ½ inch, at 4 cents		17.20
500 ft. 10-inch matched pine, at 3 cents		15.00
450 ft. 2 inch plank, at 4 cents		18.00
50 ft cherry thresholds, at 5 cents		2.50
40 ft. ash for mantels, at 5 cents		2.00
300 ft. shelving, at 3 cents		9.00
10 pairs sashes, 2-light, 18 by 30 by 1½ in. at $1.60		16.00
4 pairs sashes, 2-light, 18 by 28 by 1½ in. at $1.50		6.00
2 pairs sashes, 2-light, 18 by 24 by 1½ in. at $1.40		2.80
3 pairs sashes, 4-light, 13 by 30 by 1½ in. at $2.00		6.00
2 pairs sashes, 4-light, 13 by 28 by 1½ in. at $1.80		3.60
6 pairs cellar sashes, at 50 cents		3.00
Blinds for all, except cellar windows		26.00
1 pair front doors, 4 ft. 6 in. by 7 ft. 6 in. by 2 in		8.00
9 doors, 2 ft. 8 in. by 6 ft. 10 in. by 1¾ in., at $2.25		20.25
1 door, 2 ft. 6 in. by 6 ft. 10 in. by 1¾ in		2.00
3 doors, 2 ft 6 in. by 6 ft. 6 in. at $1.75		5.25
8 closet doors, at $1.25		10.00
Pantry doors		6.40
1 door, 2 ft. 10 in. by 6 ft. 10 in.		2.40
All hardware		110.00
Plumbing, $146 00; painting, $85.00		231.00
Carpenter labor, not included above		350 00
Range, $35.00; cartage, $25.00		60.00
Total cost		$1,969.04

—*American Agriculturist.*

HOW TO REMOVE OLD PAINT.

ON this subject Mr. McKeon gave the following information at the recent Master Car Painters' Convention, Chicago:

The only plan worthy of consideration is by burning or blistering the painted surface. This has, perhaps, some objections, but not serious ones, and we must recommend it until something better is offered. Its only objections are that the heat tends to loosen the plugs in the panels and will sometimes open up a joint, but any method of removing the paint that may be adopted will be more damaging to the work than this. What we offer now after several years thorough trial is the gasoline vapor paint burner. This is not in general use, and is new to most painters that I have spoken with on this subject.

I have used it for four years with the best results attending it. The expense of removing the old paint has been reduced fully one-half. It gives a steady heat and burns freely. The lamp, holding one quart, will burn 3½ hours, and one man can burn and scrape with ease, and a car can be burned off and cleaned ready for painting at an expense of $15. This method is superior to gas; the flame is stronger and the cost far less. You also have the advantage of being able to take the lamp to any part of the shop, which cannot be done conveniently with gas.

Three gallons of gasoline, costing 15 cents a gallon, will burn a car, and four days' labor, at $1.75 per day, making $7.45; two men at $2 per day will clean the car in two days after the paint is burned off, thus giving the total expense of burning and cleaning $15.45. Of course where we burn off a car body the battens are generally removed and new ones put on, although we frequently burn them off, especially above the middle rail of the body. Care is required in scraping off the blistered paint so that no gouging or scratches be made. The surface should be rescraped clean, then sandpapered well with block and No. 1 paper before applying the priming coat.

From a practical experience with some of the other methods we will not admit of anything that can compete with this gasoline lamp.

Scraping knives should be 1½ inches wide and stiff in the blade, square at the point, not sharp but blunt; run the knife under the blistered paint, following up the lamp closely. If care is exercised there is no need of making dents in the wood. The heavier the body of paint on the cars the easier it will come off. If the paint is very dry give it a coat of raw oil before burning, which will cause it to blister much better, and it will scrape cleaner from the wood.

This lamp will burn in any position. It will throw the flame wherever wanted. It can be spread in any shape; you can burn overhead on the roof projections as well as on the side. In fact it is the most satisfactory and economical means of removing old paint that has yet been introduced, and is preferable to all others.

I shall have very little to advance on the methods of removing cracked or decayed varnish from the inside finish of the car. After 10 or 12 years' service we find generally that the varnish is cracked more or less, and requires to be removed if a good finish is desired.

The best plan, and the only one I have ever thought was good, is by scraping the varnish off. This is the most practical way, and makes a good job if well done and sandpapered properly. But many experienced men in scraping will leave the surface in a bad condition This should be guarded against, and men who understand the work put to it, when a better foundation will be left after scraping than when the work was first turned over to the painter from the hands of the wood finisher.

Other methods have been tried, and I have tested several of them.

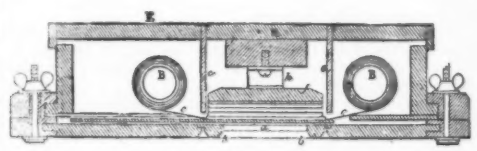
Spirits of ammonia will remove the varnish, but it requires time and repeated applications to get down to the foundation, and then when it is done you have got a rough surface, which takes a large amount of labor to prepare it for varnishing, and any preparation of this nature has a tendency to destroy the richness of the natural wood. Supposing that any of the preparations should do the work successfully and not stain or injure the wood, where is the saving made, when the varnish can be scraped off and the surface left in a good and dry condition at less labor and expense than any other method? Therefore my experience would certainly be in favor of scraping, which is by far the most safe and economical plan to pursue.

SPONTANEOUS GALVANIZATION.

M. P. PAUL, civil engineer, records a curious accident which happened in the workshop of M. Fleury. The feed water produced thick incrustations, and the proprietor was advised to put fragments of zinc into the boiler. After a few days, in spite of the greasing, the machinery began to act sluggishly. The piston began to grip, and in a few days it was almost impossible to make it move. The pump was then dismounted, and the piston was found covered with a thick layer of adherent copper. It was put upon the turning lathe, and in some places which had been made elliptical by wear, the layer was so thick that the turning was made in pure copper. The following explanation is given: The boiler was connected with the engine by copper tubes. The particles of zinc which were carried in the steam formed, with the tubes, an immense number of small galvanic couples. The piston principally attracted the copper, both on account of its own continual movement exercising an attraction of mass upon the molecules, and on account of the heat which facilitated their permanent deposit. The result seems to show that the temperature of 144° to 150° (291·2° to 302° F.) was particularly favorable to the production of the phenomena. It is probable that the electric properties of the steam also aided in its development.—*Genie Civil.*

ROLLER FRAME FOR PHOTOGRAPHIC PRINTING.

THE subjoined cut illustrates the latest developments of the roller printing-frame, and it is easy to believe that it may prove of considerable value to carbon printers, or to those who wish to make numerous impressions on gelatino-bromide paper.



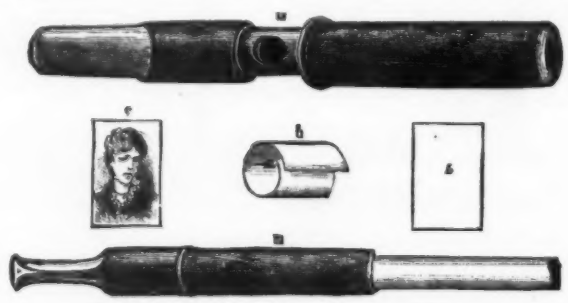
ROLLER PHOTO FRAME.

The negative is laid over an opening, *a*, which can be adapted to the required size by means of movable frames, one of which, *bb*, is shown in position. The band of sensitive paper is coiled on one of the two wooden rollers, BB, the free end being attached to the other roller, and contact between the negative and the paper is established by closing the door, *k*, so as to bring the platen, *f*, into position. After the required exposure has been given, the door, *k*, is unfastened in order to release the paper, and a fresh portion of the paper is brought into position by sufficiently turning the uncharged roller.

It is, of course, possible to place several small negatives in a line across the frame, so as to print several pictures at once. Any which are less dense than the remainder require to be sufficiently shaded with tissue or mineral paper; and the band of impressed paper may be cut up into convenient lengths for development or other subsequent operations.—*Photo News.*

MAGIC PHOTOGRAPHS DEVELOPED BY TOBACCO SMOKE.

THERE have been sold for some time, by dealers in tobacco in Paris, says *La Nature*, for the amusement of smokers, cigar or cigarette-holders, accompanied with a small pack-



PHOTOGRAPHIC CIGARETTE HOLDER.

age of plain white photographic papers about the size of a postage stamp If one of these papers be placed in the interior of the holder, before an orifice arranged for the purpose, the tobacco smoke will come in contact with it, and develop thereon a portrait or other object.

The process employed is very simple, and consists in preparing a small photograph on chloride of silver paper, and dipping it into a solution of bichloride of mercury, so as to bleach it and cause it to disappear. It is necessary to prepare the photographs without gold. The bichloride of

mercury changes the photograph partly into white chloride of silver, and partly into protochloride of mercury (which is also white), and thus renders it invisible on the white paper.

The image may afterwards be made to appear by the action of hypochlorite of soda, or by that of ammoniacal vapors.

Tobacco smoke, which contains vapors of ammonia, succeeds very well, as we have above noted, and colors the magic photographs black.

The principle of such photographs was indicated by Herschel in 1840, and more recently they have been introduced into commerce by Grüne, of Berlin.

In the annexed cut, M represents the cigarette-holder open and exhibiting the orifice; N is the same closed; *a* is one of the small plain papers, which at *b* is shown rolled up so as to be inserted in the holder, and *c* shows the paper after the image has been developed upon it.

IVORY.

By P. L. SIMMONDS.

THERE has been an outcry and discussion of late as to failing supplies of ivory, and the probability of a dearth of this valuable raw material; but at present there would appear to be little foundation for this fear, whatever there may be in the future.

Considering the animals from which it is derived, it is remarkable how comparatively regular and uniform has been the annual supply of this precious commodity, which it has hitherto been found impossible to replace satisfactorily by any artificial substitute. It is difficult, perhaps, for the ordinary dealer to arrive at any correct data to guide him in his purchases, for the official trade returns are not very clear, and he must consult a good many documents, home, Indian, and colonial, in order to get at the facts, and arrive at any correct conclusions. In the monthly Board of Trade returns, instead of having the heading ivory to turn to, he must refer to "teeth," where are mixed up tusks of the elephant with canines of the walrus, hippopotamus, and others, which might all well be commercially classed as ivory, even if they are not pure decussated dentine.

As the wholesale import trade in ivory rests in a few hands, and London is the great mart, there may be policy on the part of the importers in holding back stock occasionally from public sales, in order to enhance prices. If the subject be looked at seriously and steadily, there would appear to be no reason for any panic or undue advance in prices. There is, doubtless, a steadily increasing demand on the part of manufacturers in Europe, America, and Asia for this animal substance, but the official figures do not show any important decline in the supply of either African or Indian ivory, though small fluctuations year by year there necessarily will be in an article drawn from distant sources. We are not yet able to produce ivory in quantity in domestication, as we have done the equally valuable ostrich feather, but a passable substitute, for some of its uses, has been found in celluloid. In domestication, too, the length and quality of the tusks of the elephant are usually found to deteriorate.

Our total imports of ivory in the three last periods of five years respectively, were as follows:

	Total cwt.	Annual Average cwt.
1870	59,423	11,884
1875	67,034	13,406
1880	62,484	12,496

The supply of Asiatic ivory has not fallen off, for, in the five years ending 1880, our total imports were 18,419 cwt., giving an annual average of 3,684 cwt. The imports of the previous five years were only 9,346 cwt., an average of less than 1,900 cwt. per annum. The highest import from the East in any one year was 5,000 cwt., in 1858. But it must be borne in mind that there is a large local demand for manufacturers in China, Japan, India, and Ceylon. The imports of ivory into India in the three years ending respectively with 1st April, were, in 1880, 431,740 lb.; 1881, 471,689 lb.; and 1882, 511,829 lb., of this about half was reshipped.

From the Cape Colony the exports have nearly doubled in quantity in the last ten years; in 1878, 149,701 lb. were shipped. From Natal, owing to various causes, the exports have fluctuated from 50,000 lb. in 1870, to 37,000 in 1878. The supplies from Lagos have also dropped to a mere trifle of 1,000 lb.

The following table shows the principal quarters from which our supplies are drawn, Africa being still the chief source:

	1870.	1875.	1880.
Egypt	4,521	2,411	2,003
South Africa	1,185	1,442	1,114
British West Africa	—	251	162
West Africa, not designated	1,322	2,297	2,310
Portuguese Possessions	410	312	361
East Coast of Africa	—	696	1,099
British India	221	3,560	3,665
Other countries	4,631	5,289	2,721
Total	12,590	16,258	13,435

The officially returned imports of ivory into the United Kingdom have been as follows:

	Cwt.	Re-exported cwt.
1840	5,469	not known.
1850	9,396	"
1860	10,854	"
1870	12,590	4,039
1875	16,258	7,564
1880	13,435	7,967

It will thus be seen that we retain nearly one-half of what is received for manufacturing at home.

Those who are interested in the ivory trade and its applications, will find long and elaborate descriptions in a paper of mine in the *Art Journal* for 1874, p. 120; in my work on "Animal Products," p. 328; and in a paper read before the Society of Arts by Professor Owen, on the 17th December, 1856.

SPICES OF THE STRAITS SETTLEMENTS.

Cloves and the Clove Tree.—People that labor under the opinion that cloves do well only in the Moluccas and on the island of Zanzibar, are simply mistaken. It thrives splendidly in the Straits Settlements—this wonderful, lovely tree. Many years ago, enterprising men on the island of Penang introduced and cultivated the clove tree, and it proved a decided success. It is to be found in some of the gardens of Europeans and wealthy Chinese in the Straits Settlements, producing flowers liberally; and it is a subject for wonder why no one cultivates it more largely, not to serve as an ornament only, but to derive benefit from it. In Penang it was planted for that purpose, and "Penang cloves" have the reputation, like the nutmegs, to be the best in the market, commanding a higher price than Amboyna (Moluccas) and Zanzibar cloves. But the consumption of this spice among the natives throughout the colony (and all India and the East, in fact) is so large that the quantity left for export is very limited. It is the bud of the flower just before opening that constitutes the spice, and in this lies the difficulty that prevents many from planting cloves for export. One having a quantity of trees will find himself busy about the time the buds (white in color and strongly resembling snowdrops) begin to make their appearance. It must not be gathered before it, the bud, is well formed, just before opening; and, as on a full grown tree the number of buds is exceedingly large, the planter must have plenty of hands ready to gather them as quickly as possible, because the bud, after opening—becoming a flower—loses much of its strength. Boys and girls from ten to fourteen years old answer best for this purpose. The bud gathering time lasts a few days only, and whoever does not "make hay while the sun shines," will lose his crop of buds. The buds, after being gathered, are spread on large sieves or mats of loose texture, and dried under the shade of trees, or in sheds with palm-leaf covered roofs, and are then ready for the market. To dry them in the sun causes them to turn black and shriveled, and to evaporate much of their strength. A properly dried clove is of light brown or tan color. The shipments of cloves from Singapore to the United States have, last year excepted, never amounted to much, and supplies were obtained chiefly from Amboyna.

Pepper Cultivation.—Black and white pepper grows on the same vine. The green pepper berries, just before maturity, after gathering, turn black and make "black pepper," while "white pepper" is obtained by gathering the berries—fire red in color—when fully ripe, and through long soaking in water and subsequent stirring and shaking, relieving the berries of the outer skin; after which, on being dried, they become "white."

In what country the pepper vine originated, the writer is unable to say; but Eastern history shows that the northern half of Sumatra, the once mighty old sultanate of Acheen, when the Portuguese, Dutch, and British (in rotation) came to that country, was far famed for that spice, which drew, at Acheen Busar, in North Sumatra (near the entrance of the Straits of Malacca), the native traders from many Eastern countries and islands, who there exchanged the products of their countries or purchased for cash. After the British East India Company, during the last century, acquired the island of Penang from the Rajah of Quedah, a Siamese suzerain, so favorably situated for commercial purposes, and made it a very important factory and place of residence for a sub-governor, the great Acheen trade gradually drifted to Pulo-Penang (Prince of Wales Islands), and with it the pepper trade principally. At that time Singapore had not been acquired by the British, and not before 1819, when the island was covered with a dense trackless jungle. After the acquisition of Penang, the natives on the peninsula of Malacca, especially in the province of Frang, a Siamese souzerain province, commenced to plant pepper, and with excellent success; and now it is extensively planted by Malays and Chinese in many places on the peninsula of Malacca, also in Siam, Cochin China, and in Sarawak, Borneo. That grown in the southern part of the peninsula and on the island of Singapore, known in the market as "Singapore pepper," is by far the best, commanding a higher price than Acheen pepper.

Penang maintained the Acheen pepper trade until the Dutch commenced their war of conquest in Acheen, in 1873, blockading the coast and preventing the exports of all Acheenese products. At that time, owing to the spread of wild rumors about the destruction of the pepper gardens in Acheen, etc., pepper reached the figure of fourteen dollars per hundredweight for a short time. It was feared, the supplies from Acheen being cut off, that the spice would become scarce, and as a consequence many Chinese planters increased its cultivation; in fact, to such extent that the Acheen war was no longer looked upon as the cause of influence in prices. Later some of the chiefs of certain Acheenese provinces, having submitted to Dutch rule, were allowed to send pepper to Penang on vessels having a permit from the Dutch Consul in Penang to supply them with rice and other needed goods. Then it appeared that some of the Rajahs who had submitted to the Dutch, after having been pretty well supplied with the necessaries of life, turned truant again, and, as a consequence, their coasts were again blockaded. The Dutch are now making efforts to make "Ole-Seh," the old port of Acheen Busar, in fact well protected by a fort and man-of-war, a trading port, and to export "Acheen pepper from Acheen" themselves.

As to the pepper vine, it presents a very handsome appearance. A pepper garden at a distance looks like a "hop yard." Some planters, however, trellis the vine, and the writer thinks that is the best plan. It grows everywhere round about Singapore very easily and luxuriantly on fair upland soil, not liking low heavy soil, and, like the grapevine, needs occasional pruning, weeding, and fertilizing. With a little care and attention it yields abundantly, and proves a good source of income. The quantity of pepper exported annually from the Malay peninsula and ports in Dutch India is simply immense, and is almost exclusively planted, gathered, and brought to market by natives, Malays and Chinamen chiefly.

Nutmegs and Mace.—Nutmegs and mace belong together, the latter being the inner covering of the nut. This most interesting, and, in its natural fresh state, lovely spice, seems to be an especial favorite with the American people, since the export thereof, of the nut especially, to the United States, exceeds that to all Europe combined. The home of the nutmeg in reality is New Guinea (Papua), where it grows wild, and it is possible that in times past (and now) the famous and daring Bugistraders, who alone obtained the most noted products by way of barter with the extremely barbarous and hostile inhabitants, brought away certain quantities thereof. The most reliable place of production of obtaining them, agreeably with the demands of the market, has ever been the island of Banda, and probably other islands among or near the Moluccas, while the island of Penang and the Straits Settlements furnished also their quota, the quantity increasing gradually. The nutmeg thrives well, also, with a little care, on certain parts of the peninsula, and if the Colonial Government had given hitherto a little more fostering care to its cultivation, a much larger quantity might have been produced. In Deli, Sumatra, nearly opposite Penang, where the tobacco planters labor under the idea that their rich soil, after having produced one crop of tobacco, will not produce a second sufficiently good to pay, and that the land must lie fallow for six years (grow up in jungle again), some of them a few years ago became happily possessed of the idea whether during those six long years the tobacco lands might not possibly produce something else "that would pay," and a few of these intelligent tropical husbandmen concluded to plant nutmegs. Six good coolies, at twenty cents wages per day each, with a hand cart, could soon plant a large piece of fallow tobacco land in nutmegs. In the meantime, the tobacco planters, who looked upon this as an experiment that would not cost them much, and paying little attention to it, went on tobacco planting, looking upon that as their object and actual source of profit, as it takes about five years until the nutmeg trees commenced to bear. Some of the planters had crops of fine nutmegs to send to market at the end of that time, in addition to all the tobacco they produced and shipped during the same period. The nutmegs, being good and large, could enter the market as "Penang nutmegs"—an innocent, cheap enterprise that turned out well, the nutmegs being worth about seventy dollars per picul, unselected, and mace, if slowly and neatly dried, not scorched, about from forty dollars to fifty dollars per picul. It takes 110 fair sized nutmegs to make one pound (1 picul = 133⅓ pounds at eighty dollars) worth sixty cents; and since a good full-grown nutmeg tree in full bearing can produce several bushels of nuts with the hulls on, it can be easily seen that the "experiment" turned out well. Such of the planters as had their wits about them, the price of Deli tobacco having fallen during the last two or three years nearly fifty per cent. against former years, and yielding little or no profit at the present time, can now stop tobacco planting and find old tobacco prices in their nutmeg groves until the price of tobacco rises again. The number of the "successful," however, is not large, but will, after such a demonstration, become larger, it is supposed.

The nutmeg tree will grow well on the coast of Borneo and adjacent islands, as well as in the Malayan States on the peninsula, under British and Siamese rule; and, as we have very advantageous treaties with both countries, the United States buying more nutmegs than the whole of Europe taken together, some of our enterprising young men might, perhaps, spend some time profitably in reflecting upon this.—*Drug News.*

THE PETROLEUM WELLS OF TRANSCAUCASIA.

CONSUL PEACOCK, in his last report on the trade and industries of Baku and Batoum, calls attention to the increased production of petroleum in the former district, and states that the total area of the Baku petroleum region, taking its extreme points of surface oil, gas wells, etc., is not less than 1,200 square miles; its elevation above the level of the Caspian Sea varies considerably. The Caspian is 86 feet below the level of the ocean. The general aspect of the petroleum region is that of a barren desert, deprived of water and vegetation, checkered here and there with dried up salt lakes, natural outflows and pools of oil, gas wells, and exhausted mud volcanoes. Even on the surface of the water of the Caspian, natural outflows of petroleum and gas may be seen at certain places. The boring operations are mostly carried on in the peninsula of Apsheron, where the potential productiveness is considered to be much greater than that of American petroleum regions. It may be justly stated, says Consul Peacock, comparing the results achieved in the two countries on the one hand, and the average depth and total number of the wells on the other, that the natural petroleum riches of Baku have no parallel in the world. The lands are partly purchased and partly held by lease. The former comprise about 1,836 acres, sold by the crown to different persons, by public auction, for the sum of £300,000; for certain plats as much as £3,500 per acre has been paid. The yearly rent for leased crown land is only about 7s. 6d. per acre. These lands were, some few years ago, supposed to be worthless, but the contrary has been proved since, and they now form a subject of wild speculation among the numerous leaseholders. A tract of the most valuable land, with an area of 270 acres, has been granted to a certain number of high officials, as a token of imperial favor. In 1873, the number of wells sunk by way of drilling was 17. The total number now is about 375. The average depth of borings is 350 feet, and the deepest well 637 feet, with a diameter from 10 to 14 inches. The number of unproductive wells from natural causes is comparatively small, but a great many are abandoned for want of means or skill to continue the boring, or still more frequently on account of the extremely low price of crude petroleum. Flowing wells, yielding from 3,000 to 4,000 barrels (40 gallons to the barrel), and pumping wells, yielding from 300 to 600 barrels daily, are of common occurrence.

Within the period of fifty-nine years' monopoly—from 1813 to 1872—the maximum yearly production of crude petroleum never exceeded 212,000 barrels; in the first year of free competition it at once more than doubled, and the average production annually for 1879, 1880, 1881, amounted to from 3,000,000 to 4,000,000 barrels, and besides this, immense quantities of crude petroleum are wasted at the place of production for want of adequate means of tankage and transportation. The extraction of petroleum for domestic use has been carried on by the natives from time immemorial. It became a resource of commerce about 1813, and formed a monopoly till 1872, when the system was finally done away with, an excise duty being imposed on refined petroleum, which, in its turn, was abolished in 1877; and it is since that period that the petroleum industry, being virtually thrown open to free competition, commenced to attract enterprise and capital on a scale unexampled in Russia.

Petroleum refineries have lately sprung up in great numbers, and there are, at the present time, 193 refineries, with 487 stills, of a daily working capacity of 300,000 gallons of refined petroleum. The price of kerosene at Baku, during the period from 1870 to 1879, has fluctuated between 1s. 8d. and 3d. per gallon. The different products derived from petroleum in their respective application for illuminating, heating, and lubricating purposes, have proved of immense importance as substitutes for other less abundant natural riches. In 1881, the petroleum products exported from Baku by sea, amounted to 2,946,000 barrels, and these included 1,450,000 barrels, or 58,000,000 gallons, of kerosene, the rest consisting of crude petroleum refuse and lubricating oil. Some works have lately been completed to facilitate the

manipulation and marketing of the produce; a railway line, ten miles long, with tank cars, connects Balakhane, the principal group of wells, with Baku; the wells, refineries, and piers are also connected by several pipe lines, their total length being about sixty miles. A large number of tank steamers and several hundred sailing vessels, have also been built specially to carry the petroleum without casks. The Baku harbor has 25 piers, and some of them are furnished with pipes and pumps, so that tank vessels may be loaded at the rate or 100 tons per hour.

THE AGE OF ELECTRICITY.*

By PROF. S. P. THOMPSON.

IT is the fashion among ethnologists to classify the successive stages of development in the primitive races of mankind by reference to the kind of implement which marked the degree of civilization to which they had attained. A chipped flint arrow, a bronze spear-head, an iron dagger, are typical of the several grades of advancement in material civilization which we familiarly name the age of stone, the age of bronze, the age of iron. To these three primitive ages you must allow me to add three others, equally well defined—the age of gunpowder, the age of coal and steam, and the age of electricity. The world is even now entering upon a new, and I am fain to believe a happier, age, wherein, while delivered to a large degree from the darker aspects, we shall enjoy to a degree hitherto unknown the advantages of machine-aided production. Our machinery will be driven, not by steam, but by electricity; for electricity will be our servant to do the hard work of the world in the coming age. For a quarter of a century we have harnessed that messenger, more nimble than fleet-footed Iris, to convey our thoughts. We have but lately discovered that electricity could also convey the actual tones of our speech. It is electricity that rings our bells, that silvers our pewter and gilds our pinchbeck, that fires our torpedoes, and brings Greenwich time to our clocks. True, these are light and easy duties, but it has taken us many years to adopt in practical life these simplest applications. And, mark you, the delay is not to be imputed to science, for science has known most of these things for forty years. Mines were fired by electricity in 1749; electro-plating with silver was discovered in 1805; an electric telegraph was in actual operation in London in 1816; electric bells were invented in 1834; electric clocks were made in 1840; and speech was transmitted by an electric telephone in 1861. But, familiar as are these services to mankind, there are other services of a very important nature which electricity is perfectly competent to perform, which, unless the world has grown wiser, will not, I suppose, be generally adopted for the next forty years. Electricity can bring us a magnificent and economical light. It can smelt our most refractory metals. It can bleach our cottons and print our calicoes. It can detect base coins without cutting them, and can discover a bullet in a wound without probing it. It can stencil our circulars, grind our coffee, gather our apples and walnuts, protect us against burglars, turn our sewing machines, drive our tricycles. Nay, it can perform much heavier work. It can turn lathes, saw timber, grind scissors and knives, plane planks, propel tramcars, and, as I can personally testify, can furnish motive power of a very effective kind to an iron boat. Surely we have reason to say that the age of electricity has already begun. The success of primitive attempts to utilize electricity as a motive power was not very encouraging, for their cost was great and their power weak. The fact was that though the machinery—on a small scale at any rate—was ready, the time was not ripe for it. Compact and light in weight, these little electric motors presented, for light kinds of work, an enormous advantage over steam engines; yet these advantages were far outweighed by the consideration that the cost of generating electric currents in the voltaic battery was so enormous as to be practically prohibitive. The great stride which has brought so many of the possible applications of electric currents into the region of practical problems is due in its origin to the genius of Faraday. With the invention and perfection of the dynamo between the years 1863 to 1872, a new range of possibilities was opened out. Electric lighting, to which the real obstacle had been all along the extravagant expense of producing electric currents, at once began to develop, and the Jablochkoff candle, the Siemens lamp, and the Brush lamp, which sprang almost simultaneously into existence, found themselves shortly confronted by a host of brilliant rivals for fame. Then first it became clear that electric currents might be laid on from house to house in order to supply domestic electric lights. Little lamps of the requisite compactness and brilliancy were speedily perfected by Edison and Swan, on the lines of an old invention of thirty years back, impracticable then, practicable now by reason of other advances in science. The vast possibilities opened out by the fact that a simple wire may convey electric currents to any distance now began to assume their true importance. The electric transmission of power to any distance, and the possibility thereby of utilizing some of the waste forces of nature, became a burning question. The invention of the electric accumulator, by Planté, in 1860, and its improvement by Faure, in 1881, suggested the further cheapening the cost of electric currents by providing a means of thus storing the intermittent energy of waves and winds. The electric railway made its appearance in Berlin, to be followed by the electric tramway of Paris, and various projects for electric railways elsewhere. Electric industries of all kinds grew and multiplied; in fact, with the invention of the dynamo machine we leaped into the age of electricity with a sudden bound. Now, as the first achievement in the age of electricity appears to be the spread of the electric light, I will speak of that development first, though it is not, in my opinion, the most important. The blaze of the electric arc light can be maintained by the consumption of a far smaller quantity of coal than would be required for the production of an equal amount of light by gas. So far there is economy —real and not small. But it may be said, "We don't want such overpowering displays in our houses even if we could afford them. There can be no economy in using a light far too brilliant for comfort." It is here that the incandescent lamps, such as those of Swan, Edison, and others, come in to give us exactly the brilliancy we need. Here, however, we are met by the disappointing circumstance that the very same electric consumption which will give us one blazing arc light of one thousand and more candle-power will, when applied to light a score of incandescent lamps, only give to the latter a brightness of eight candles each; or, in total, one hundred and sixty candles. It is clear, then, that the economy of small incandescent lamps is a different thing from that of arc lights. And I am quite certain that up to the present time, if any one has fixed incandescent lamps in his private house, and has erected his own dynamo and steam engine or gas engine to feed his lamps, he will have found no saving over his gas bill. I say this with less hesitation, because, when the circumstances are looked at narrowly, it will be seen that for a fair discussion of the question of economy, the comparison is not a fair one. To set up little electric works of one's own in one's own house cannot possibly be as cheap a method of generating the electric current as to have it generated at central stations on a large scale by large and economical machinery. No sane man would think of saving on his gas bill by setting up small gas works in his cellar, and by building a private gas meter in his back garden. The fair comparison must be made between gas as distributed from a central station on a large scale, and electricity as distributed from a central station on a large scale. That large scale distribution has, so far as I am aware, been yet only attempted in two places—New York and the Holborn Viaduct in London—and in both cases a system which is not necessarily by any means the best, or most economical —I mean Edison's—is the system tried. Yet I look forward with the greatest confidence to the results of those experiments, as showing not only that electricity can be distributed on the large scale, but that it can be so done with economy and profit. This regular and systematic distribution of electric currents on a large scale, by means of conductors laid along the streets, is the first step to the further economic applications of electricity, and is becoming now a pressing necessity of the time. A century hence a supply of electricity will be just as essential as a regular supply of gas and of water has become to-day; a hundred years hence the town without an electric supply will be deemed as badly off as nowadays a town which has no railway or telegraph. A general system of electric distribution is needed, not for electric lighting only, but for hundreds of other purposes of which we now dream little. Once let such a system be established, and we shall see how soon it will be found that there are many kinds of additional services which electricity can perform for us. When it is possible thus to obtain power by merely turning on a tap, there will be an enormous impetus to all kinds of small machinery. Motors to work sewing machines already exist, and would be used literally by millions if the source of electricity were but at hand, in the form of a friendly wire always ready to bring the needed power. If we have a system of electric distribution, lifts or elevators will be multiplied. An electric lift is both simpler and cheaper than a hydraulic lift, which will probably be suspended entirely at no distant date. Indeed, there are many hydraulic appliances which must at a very early date be superseded by electric machinery. Again, the establishment of a town supply of electricity will tend unquestionably to develop the industries of small workshops and home workshops, where a little power is required. The smallest electro-motors may be made just as economical as are the largest. There is, moreover, another point in their favor. They may be made far smaller, lighter, more compact, and far cheaper than steam engines of corresponding power. It is certainly possible to construct an electric motor of two-horse power for a cost of ten pounds, and such a motor would be ample for the purposes of many small workshops. Why do we not, it may be asked, hear and see more of these little machines if they are so excellent? Why do not people adopt them? The answer is simply, they cannot be used until we have a central supply of electricity. I do not hesitate to affirm that such motors will be found to present an enormous economy in comparison with steam engines of equal power. It is clear, then, that electricity offers an enormous future to small motor machinery. A further economy is, indeed, possible. Electricity will travel any distance along wires without sensible loss, provided those wires be thick enough. Instead, therefore, of erecting our steam engines at a central town station, where ground is dear, and where we shall have to pay dearly for transporting coal, let us put our steam engine and dynamos at the pit's mouth, and transmit our electricity to town through a stout copper cable. The saving of freights would much more than pay the interest on the cost of the cables required. One further step in economy is also within the range of possibility; and that is to use water power or tide power to drive our dynamos. If the problem of utilizing the tides remains yet unsolved for want of suitable tide mills, that of utilizing the power of waterfalls by turbines is already solved, and only wants putting into effect. Niagara is not yet harnessed to the car of electricity, and is possibly too far off to supply Great Britain; but there are waterfalls enough in Scotland and in Norway to satisfy our wants for a long time to come. Of this at least, I am convinced, that we do not yet realize the hundredth part of the future services which electricity can render to us when once it is supplied wholesale. Before the electric age is over, our knives will be polished, our shoes cleaned, our mangles driven, our coffee roasted, our potatoes pared, and our mincemeat chopped by the self-same agency that will bring light into our dwellings. In all kinds of machinery, small first, large afterward, we shall see a complete revolution. In a very few years we shall see electric governors replacing the rotating governor balls for regulating the power of steam engines. The locomotive steam engine is irrevocably doomed. Why should we employ an enormous and expensive lumbering mass of metal, loaded with boiler and coals, and burning four pounds of coal per horse power per hour, to draw our trains, when we might equally well draw them by electric motors of one-tenth part of the total weight, drawing their supplies of power electrically from a large and far more economical stationary engine at one end of the line? (Hear, hear.) There is every argument in favor of this radical change—economy both in prime cost and in actual working, safety, and certainty of action. But railway directors do not yet know or realize the magnitude or certainty of the impending revolution. Having hinted, amid applause, at the prospect of electric power superseding steam on the Metropolitan Railway, Professor Thompson continued: Setting aside all that deals with electric telegraphs and telephones, and confining ourselves only to the industries connected with electric lighting, the manufacture of dynamos, and of electric motors and their appliances, we shall find that in the electric industry to-day there are employed in England alone something like five thousand persons. Practice of the actual work of the shops is of course outside the range of the operations of such a college as ours, but the work of the electrical laboratory is just as truly within our range as the work of the dissecting-room is within the range of the medical school. I look upon education in matters electrical, indeed, as a pressing necessity of the time. That nation which can earliest establish such a system of distributing power among its artisans will be placed in a most advantageous position for production, and such a nation will reap its reward in the rush of commerce to its doors. That city which rises to the golden opportunity in store will in like manner reap its due harvest of returns.

* From a lecture delivered October 7, at the University College, Bristol.

UNION OF THE THREE AMERICAS BY TELEGRAPH.

PANAMA, September 16, 1882.

THE cable steamers Silvertown and Retriever have returned and are now anchored in this bay, their work having been completed in the most satisfactory manner. The cable work and direction of the whole enterprise has been under the immediate care of Mr. Robert Kaye Gray, F.R.G.S., chief engineer representing the contractors, the India-rubber, Gutta Percha, and Telegraph Works Co., Limited, of Silvertown, London, England.

Mr. Joseph B. Stearns, a celebrated American electrician and the inventor of duplex telegraphy, is here representing the new cable company, whose title is the Central and South American Telegraph Company. Mr. Stearns, by the way, is well-known "at home" in Canada. His system is used by the Montreal Telegraph Company. He and Mr. Badger, of the Montreal Fire Telegraph Department, worked together before Mr. Badger left Boston to take up his residence in Montreal. Mr. Stearns has taken the position of general manager of the new enterprise *pro tem.* When all is complete he will hand over his charge to the president, and return to England, his present headquarters.

The cables laid by the International, Dacia, Retriever, and Silvertown, for the new company by the contractors' fleet, comprise some 3,200 miles of marine cable. The Central and South American Telegraph Company also have 313 miles of land lines working in connection with their cables as above.

The new company is American, and has its head offices in New York. The lines of the Mexican Telegraph Company run from Galveston, Texas, to Vera Cruz, Mexico, where the cable of the Central and South American Telegraph Company commences. The stock in both companies is nearly all held by the same shareholders. One president, Mr. James A. Scrymser, of New York, acts for both companies. The cables of the Central and South American Telegraph Company extend from Salina Cruz, in the Gulf of Tehuantepec, Mexico, on the Pacific side, to Lima, in Peru; there the cables of the West Coast of America Telegraph Company begin, and extend to Valparaiso, Chili, to be described later.

The connection of the Central and South American Telegraph Company with other ocean and land lines, will give a total mileage of over 20,000 miles, in Mexico, Central and South America, and with the trans-continental line, an additional 6,250 miles, or in all 26,250. Here is a truly vast system of telegraphic connections just completed.

The three Americas are united by the cables of the Central and South American Telegraph Company for the first time. All honor to American enterprise.

Previous to the inauguration of the new company there was no direct communication by telegraph between these countries, as stated. For example, to send a message under the old *régime* to South America it had to be sent from New York *via* Newfoundland to England; thence by land lines and cables to Lisbon, Portugal, thence by cables to Madeira and the Cape de Verde Islands, and from the latter to Pernambuco, in Brazil. It will be seen that a message had to cross the Atlantic twice ere reaching the Atlantic coast of South America. Once there it could be sent up and down the coast by the cables of the Brazilian Submarine Company, from Para, on the north, the neighbor of French Guinea, to Montevideo, in Uruguay, on the south; thence by a land line across the continent *via* Rosario, Mercedes, and Mendoza in the Argentine Republic, to Santiago and Valparaiso, Chili, thus reaching the Pacific or west coast of America, whence messages could be sent as far north as Lima by the West Coast of America Telegraph Company, an English corporation, whose manager is Edward William Parsoné. To fully illustrate how awkwardly people were placed in Panama and Callao when they had to cable to each other, the following will show. Let us suppose that A of Panama had to cable to B of Callao, distant only eight days by the English steamer. His message had to cross the Isthmus, thence to Jamaica, Havana, Key-West, to New York, thence *via* Newfoundland to England, over the continent to Lisbon, from thence to South America, arriving at Pernambuco, thence *via* Montevideo across the continent to Chili, thence up the coast to Callao, at an expense of nearly $13.00 a word. It would have to travel over 14,000 miles of cable and 7,680 miles of land wire, in all nearly 22,000 miles—pretty well around the world. This was not only tedious and very expensive, but at times almost useless, owing to the land wires in South America being in a chronic state of "down," so that the mere paying for a message was often the easiest part of the whole affair. Such was not the exception, but the rule. Important messages often had to be sent on horseback across the wild pampas of South America. Now it is but fair to assume that under the new era these annoyances have been relegated to the past, and the three Americas are in direct electric connection. Messages can be sent by either North or South America or the Isthmus of Panama to Europe, or in a word, all over the inhabitable globe.

Now how is this done under the new order of things? Simple enough. A cablegram from either Mexico, Central or South America, on the Atlantic or Pacific side (in some places) can be handed into the office of the Montreal Telegraph Company "at home," or to any of the Western Union offices in the United States. It will then be forwarded direct to Galveston, Texas, thence by the cables and land lines of the Mexican Telegraph Company to Vera Cruz, Mexico, Atlantic side; thence it travels over the first section of the Central and South American Telegraph Company's cable to Coatzacoalco, a small Mexican village situate at the mouth of the river of the same name, a distance of 138 miles, in the Gulf of Mexico; this section was laid by the contractors' steamer International, in March, 1881. The land line starts from Coatzacoalco and crosses the Isthmus of Tehuantepec, a distance of 195 miles, and terminating at Salina Cruz, near the Mexican town of Tehuantepec, on the Pacific Ocean. Here the company are credited with having profited by the experience of the Western Union Telegraph Company, whose lines in the early days of telegraphy were of small wire, No. 16; these were often cut on the "wild prairie" by the gentle savage of Uncle Sam's neglected family. A No. 9 or a larger wire was then employed that was practically useless to the redskin. The Central and South American Telegraph Company here "give one better," by using a No. 8, a larger wire having a greater message capacity.

To return to Salina Cruz. It is the northern terminus of the Central and South American Telegraph Company on the Pacific, and from it the first section of cable runs south a distance of 435 miles, to La Libertad, in Salvador. At the latter port the company makes its first connection with the telegraph system of Central America. The names of the Central Spanish-American Republics now in direct communication with each other are as follows: Guatemala, Hon-

duras, Salvador, Nicaragua, and Costa Rica. The second section extends to San Juan del Sur, Nicaragua, a distance of 2,694 miles, and from the latter place to the Island of Pedro Gonzales, the distance to the island being 671 miles. The Island of Pedro Gonzales is in the Pearl Island group, nearly opposite the Isthmus of Darien. The Pearl Islands are known the world over for producing the largest and most valuable pearls. The Isthmus of Darien produces—well, crocodiles, India-rubber, big trees, and a *fever* that has been celebrated since the days of Paterson's colony. The name of Paterson is well known to English readers as the founder of the Bank of England. His famous Darien scheme received the royal sanction in 1695. Paterson landed 1,300 men in Panama, nearly all Scotchmen, who proceeded to Darien to found his New Edinburgh. Between fighting the Spaniards, destitution, and fever, the little colony was all but "wiped out." History informs us that but thirty reached Scotland, and of them says "they were too weak to weigh the anchor of the vessel which was to carry them home, and had to be assisted in their departure by the Spaniards." *Vide* Macaulay *et al.*

From Pedro Gonzales Island a section runs in back of the island of Toboga, one to Brighton, a distance of 49.4 miles to the city of Panama. The landing of the cable here, and its having been buried in trenches on its way to the company's Panama offices has already been referred to in the *Gazette's* Panama correspondence. At Panama it connects with the Panama Railroad Company's telegraph, across the Isthmus of Panama to Colon (*via* Aspinwall) on Navy Bay, Atlantic side, thence by cables to the West India and Panama Telegraph Company, an English corporation, to all its important West Indian Islands, as well as with British Guinea or South America. Messages can also be sent by the same company *via* Cuba and Key West to Europe, as already described.

From Pedro Gonzales Island another section of cable runs a distance of 358 miles to Buenaventura, where it connects with the land system of the Colombian government, estimated at 3,000 miles, the objective point of the latter being Sante Fe de Bogota, or the capital of the United States of Colombia, an all but inaccessible place away up in the mountains, 8,000 feet above the sea level. It is more than a "Sabbath day's" journey to our Paris.

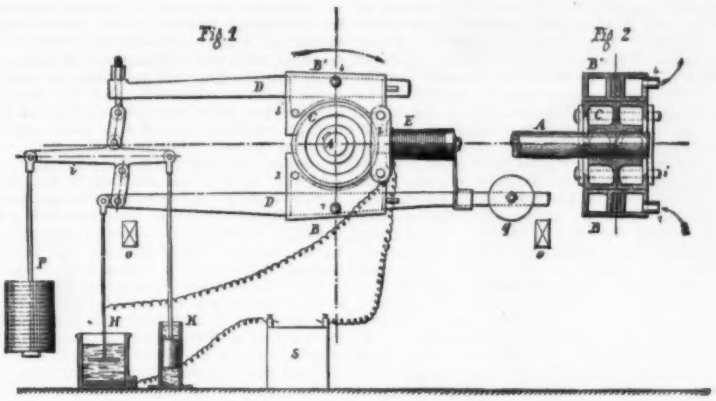
From Buenaventura another section extends 486 miles to Santa Elena, in the Republic of Ecuador. Santa Elena is nearly under the equator, and is at the mouth of the Guayaquil River. The city of that name is 111 miles up the river, and is the principal port of Ecuador. A land line runs from Santa Elena to the city, also belonging to the Central and South American Telegraph Company. If the writer is not mistaken, this is the first telegraph line in Ecuador—another triumph for American push and investment. Strange to say, Old England sells the world their cables. We may say without fear of contradiction that England is the sole manufacturer of cables. It is true that there is a manufactory for them in France, but it is a branch house of the company who took this contract; English cable ships, English cables, Englishmen, English capital, and English skill are always to the fore. Our American cousins show their good sense in purchasing from our common parent what they cannot produce themselves.

From Santa Elena a section runs to Payta; its length is 222·019 miles. Payta, as the readers of the *Gazette* are aware, is the principal northern port of Peru, and possesses great commercial importance. A Peruvian land line extends from Payta to Lima, its capital. The latter is wretchedly uncertain (not the capital, the line), and constantly "ailing." To avoid all difficulties, the Central and South American Telegraph Company have added a final section of 552·9 miles to Chorillos, within a short distance of the capital. A land line of the Central and South American Telegraph Company, seven miles long, connects Chorillos with Lima. Lima is the southern terminus of the new company, and the northern terminus of the West Coast of American Telegraph Company, the cable of the latter, as already said, extends 1,099 miles to Valparaiso, Chili, touching the coast of Peru, at Mollendo, Arica, Iquique, and Autopogasta, formerly Bolivia's only seaport, thence to Caldera, Sarena, and Valparaiso. From Valparaiso a land line—that referred to—stretches across the vast continent; thus the Transandine Telegraph Company is a Chilian corporation. We of the Pacific coast, thanks to the new company, can now send our messages to Europe by three different routes. If the cables and lines were clear, a message could be sent from your correspondent's office in Panama around the world and back to himself in a very few minutes. It would travel some 23,000 miles *via* Chili and Uruguay to Europe and back *via* Montreal, Texas, and Mexico to the Isthmus of Panama. The mind is all but dazed when one commences to contemplate what skill and capital are daily accomplishing in this great world. The tendency of the whole is to benefit mankind and advance civilization. The millennial period of "plow shares, pruning hooks, etc.," is left for the future, as well as several letters on cables, cable ships, and cable laying, to be written in an everyday way for everyday readers.—*Montreal Gazette, September 25th.*

ELECTRIC COMPENSATOR APPLIED TO THE PRONY BRAKE.

THE usual locking of the jaws of the Prony brake by means of bolts has the advantage of being very simple, but it also has the disadvantage of requiring a certain amount of skill and constant attention on the part of the workman charged with keeping the lever-arm in equilibrium; and often, especially in experiments of long duration, the exactness of the results sought is at the mercy of the person who regulates the brake. It may be seen, then, that for comparative experiments designed to establish the relative merits of different motors, regulation by hand does not offer all the guarantees that are desirable, since it permits, in a certain measure, of one competitor being favored at the expense of another. This is why a means of operating the locking of dynamometric brakes automatically has been sought for a long time. The most complete solution of this important problem is the funicular brake of M. Carpentier, which, it is true, is only applicable to the measurement of very small powers. The dynamometric balance founded upon the same principle allows of measurements being made up to six horse power, but beyond that the apparatus would become costly and non-transportable. It is necessary, then, to return to the Prony brake, and to endeavor to render its working automatic without complicating it too much. Amos's compensating lever is very simple, and works admirably, but can be applied to the Prony brake only in particular cases. For this reason I have sought another combination. The one that I have adopted may perhaps appear a little complicated, but it has the advantage that it solves the problem completely and is applicable to all the dynamometric brakes known.

Figs. 1 and 2 represent a Prony brake in which the locking of the jaws is effected automatically by the very weight of the load of the brake. The proportions of the lever arms are so calculated that the pressure exerted on the pulley is almost sufficient to keep the brake in equilibrium through the effect of friction when this attains its maximum value. The friction itself of a regularly oiled surface not being constant, and always varying between certain limits, it is necessary, in order to insure of an equilibrium, to have recourse to an additional variable force which shall act automatically and to the degree desired, so as to re-establish the constancy of the friction and insure of the equilibrium of the weight, P.



ELECTRIC COMPENSATOR.

The force that I employ is that of an electro-magnet, E, whose armature presses more or less on the movable pulley. According as the exciting current is more or less intense, a regulator, H, connected with the arm, D, of the brake increases the intensity of the current when the arm goes down, and diminishes it as soon as it rises; the action of the electro-magnet insuring, then, of an equilibrium within as restrained limits as possible. This regulator, in which there is nothing new, is formed of two metal plates immersed in a liquid that is not much of a conductor. One of these plates being connected with the arm of the brake, the thickness of the liquid which separates the two, and consequently the resistance of the circuit, varies with the position of the arm. The electric current may be furnished by any source whatever, S, dynamo-electric machine, pile, or accumulator.

Some time ago, the idea of using an electric current to regulate the locking of the Prony brake would have been considered strange; but now that electric apparatus are better known and more common, there is no reason why they should not be used where other mechanical means cannot be employed.

To terminate the description of the apparatus, it remains for one to speak of two arrangements which are peculiar although not entirely new. The first consists in the use of the water-brake, of which I have already shown the necessity for facilitating experiments with the Prony brake, and the utility of which is no longer disputed, since it is beginning to be employed in a general way in all dynamometers for attenuating those sudden motions and those starts that are always inevitably produced in this kind of apparatus.

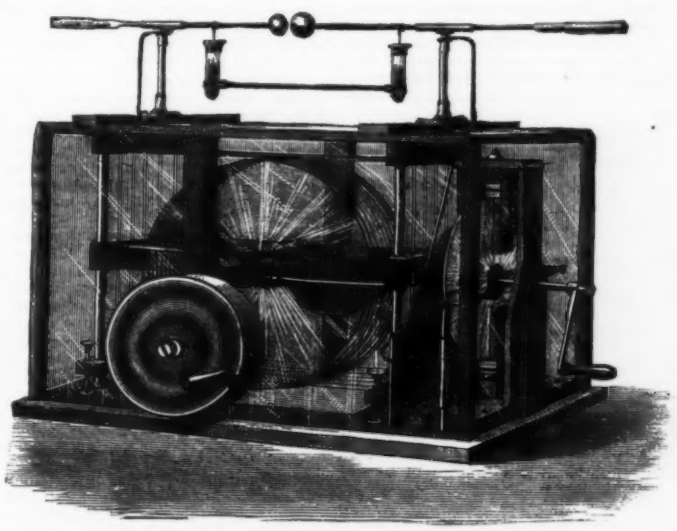
brium through the friction produced. E, electro-magnet compensator whose armature presses on the pulley, and which is excited by a current that varies in intensity with the position of the arm so as always to hold the weight, P, in equilibrium, whatever be the accidental variations in friction. H, resistance apparatus in electrical communication with the accumulator, S, and the electro-magnet, and which increases or diminishes the resistance of the circuit according as the arm rises or descends. I, system of levers and links upon which the weight, P, acts to produce the locking of the jaws. K, water-brake for abating the sudden motions of the brake. O, stops for limiting the oscillations of the brake-arm. P, weight of the brake, which produces the locking necessary for its equilibrium. Q, counterpoise for balancing the part of the brake with respect to the axis, A. S, accumulator in communication with the electro-magnet and the variable resistance apparatus.—*N. J. Raffard.*

IMPROVED INDUCTION ELECTRICAL MACHINE.

THE history of induction electrical machines, of which perhaps the Holz machine is the best known modern type, dates as far back as about a hundred years ago, when the immortal Volta, the father of electrical science, added the electrophorus to the apparatus of the electrician; and just as the celebrated pile of the same pioneer, or the modification of it to which he gave the name of the "*couronne de tasses*," must ever be regarded as the type and precursor of all voltaic batteries, so must the electrophorus be regarded as the origin and germ from which have been developed all the electrostatic induction machines of the present day.

We have from time to time described and referred to the induction machines of Bennett, Nicholson, Holz, Carré, Bertsch, Varley, Sir William Thomson, Töpler, and Voss, all of which may more or less be regarded as modifications of Volta's electrophorus, and all of which depend for their action, in part or in whole, upon the building up, from a small initial charge of electricity, and by a succession of inductions and counter-inductions, a far more powerful and accumulated charge, capable when desired of producing the most brilliant effects of static electricity.

Up to within a very recent period the most powerful and certainly most widely known machine of this class was that introduced by Mr. Holz, of Berlin, in 1865, and which is to be found in all the important physical laboratories; but the



NEW INDUCTION MACHINE.

The only thing new is that here the rod of the water-brake, K, is not connected directly with the arm of the brake, but acts at the extremity of a lever, thus permitting it to fulfill at once two functions: (1) that of resisting all sudden motions of the brake arm; and (2) that of rapidly modifying the locking of the jaws by unlocking them when friction increases suddenly, and locking them, on the contrary, when the opposite effect is produced. The following is a description of the figures.

Fig. 1. Elevation of front view. Fig. 2. Profile, with section through a vertical plane. A, shaft of the motor (the arrow indicates the direction of the motion). B and B', lower and upper jaws of the brake. These being hollow, a current of water circulates in the cavities, entering through the aperture 1, passing from orifice 2 to orifice 3 into a flexible tube, and finally making its exit through aperture 4. G, pulley of the brake keyed upon the shaft A. P and D, levers traversing the jaws, and forming with other levers and links a system by which the weight, P, exerts on the pulley, C, a pressure almost sufficient to keep it in equili-

Holz machine has one very serious disadvantage, and that is its dependence upon a favorable state of the atmosphere for successful working; in a climate such as ours in England, there are comparatively few days in the year when a Holz machine can be made to work without great coaxing and difficulty, unless means be adopted for artificially drying the air in the immediate neighborhood of the revolving plates; moreover, the cost of the machines has always been very great. A little more than a year ago Mr. Voss, also of Berlin, introduced an extremely interesting form of Töpler's machine, which we described at the time; this was remarkably independent of atmospheric influence, appearing to work almost as well in damp weather as in dry, but its form did not admit of a number of plates being united to the instrument, as in the compound Holz machines, without very largely and inconveniently increasing its bulk.

We illustrate a highly interesting and valuable machine, the invention of Mr. James Wimshurst, one of the Consultative Staff of the Board of Trade, which, while possessing all the power of the best Holz machine, is as completely in-

dependent of the state of the atmosphere as is the Voss machine, and what is perhaps more important to the majority of scientific men and others requiring a powerful source of static electricity, it can be made and sold at a remarkably small price. Mr. Wimshurst, having himself constructed several experimental machines of the same type, has been enabled to bring the design to a very high degree of perfection, and in its improved form the instrument is now being introduced by Messrs. Paterson & Cooper, of Little Britain. An apparatus of this class has been recently made by Mr. Wimshurst, and is, we believe, the most powerful electrostatic induction generator in existence; with it all the most brilliant and powerful effects of static electricity may be produced with no more expenditure of power than can comfortably be transmitted by the turning of a wheel by one hand. This machine, which we have had opportunities of seeing at work under atmospheric conditions that would be fatal to the working of a Holz machine, and at a time when all its parts were covered with dust, is capable of giving dense bundles of spark discharges in the open air, upwards of 7 in. long between its terminals, and when small Leyden condensers are attached to its terminals the sound of the discharge is almost deafening. The discharge is capable of piercing all the pages of a Bradshaw's sixpenny railway guide, and most of the brilliant effects of the discharge through vacuum tubes may be exhibited in a most remarkable degree. This machine consists of twelve circular disks of ordinary window glass, 32 in. in diameter, mounted upon an insulating spindle, which, by simple multiplying gear, can be rotated at a high velocity by hand. These disks rotate between twenty-four rectangular slips of window glass, twelve above and twelve below the axle, the space between the upper and the lower sets being sufficient to allow the spindle to pass freely between them. These slips are not fixed in any way, but are simply dropped into grooves to receive them, and can in a few minutes be all removed, cleaned, and replaced; they are not coated with varnish or any other insulating substance. The rotating disks run freely between the plates without touching them, so there is no friction in the working of the apparatus except at the bearings, which is inconsiderable, as the disks, being of thin window glass, are extremely light. It is true there is a series of paper "armatures" or combs on each side of the spindle which rest against the revolving disks, but then contact with them is of the lightest possible character, and offers no resisting friction to the working of the machine. Mr. Wimshurst has effectually protected the apparatus against one defect to be found generally in induction machines with several plates; that is, the existence of different polarities in the armatures on the same side. For the successful working of the apparatus all the armatures on one side should be positively electrified, and all those on the other side should be of the opposite sign; generally in compound induction machines this is not the case, and a large proportion of the useful effect is lost by neutralization. To prevent this Mr. Wimshurst connects all the armatures on one side together by a fine wire, which terminates on the outside of the case and serves as a conductor for giving to the apparatus its initial charge, which can be produced by an electrophorus or by an ebonite rod excited by friction.

In the smaller machines which are being made by Messrs. Paterson & Cooper, and which are shown in the illustration, a small frictional plate machine of the ordinary type is fixed at one end of and within the case, for the purpose of producing the initial charge, but this addition, while making the whole apparatus very complete and self contained, adds considerably to the expense. If the machine be well insulated the smallest possible charge is sufficient to start the induction, and in our opinion a very much smaller and less costly generator for this purpose might with advantage be substituted for the extra plate machine.

There can be no doubt that Mr. Wimshurst has added a very valuable instrument to the laboratory of the physicist, and we feel sure when it becomes known that powerful electrostatic induction machines can, by carrying out his principle of construction, be made with the simplest possible materials and at remarkably small cost, it can only be a matter of a short time for these interesting machines to take the foremost place among electrostatic generators, and another will at the same time be added to the long list of honored names who have advanced the science of electricity.—*Engineering.*

ELECTRO-MAGNETISM AS A PRIME MOVER.

THE dangers to which persons are exposed from the explosions of boilers while traveling in vehicles propelled by steam power, though now comparatively rare, still occur to such a degree as to render desirable the adoption of any other means of transit unobjectionable on that point, and which, at the same time, holds out the prospect of being equally economical and effective. To many the power derived from electro magnetism may appear totally unworthy of consideration when they compare what has hitherto been done with the stupendous effects produced by the agency of steam; but it must be remembered that nearly two thousand years have elapsed since the first application of the vapor of water as a prime mover, and that it is only recently that the steam engine issued from the hands of Watt in a state admitting, apparently, of little improvement. Even one hundred years ago no person would have believed that there slumbered in a few gallons of water a power equal to that of hundreds of horses, and which, when applied to machinery, would, in defiance of wind and tide, impel the largest vessels to the remotest corners of the globe, raise thousands of times its own weight from the bowels of the earth, and propel trains of carriages with a speed which her fleetest coursers cannot equal. All this would have appeared to our forefathers as the ravings of a distempered or over-sanguine brain; and had the ridicule been effective which was lavished upon those who at first labored to produce such results, advantages of incalculable value to society would either have been entirely lost or reserved for discovery by future generations.

In the application of electro-magnetism to the various purposes which at present occupy the power of steam, difficulties are unquestionably felt, and, when these are removed, others may start up, but this is no reason for altogether relinquishing the investigation of the subject. The discovery of these difficulties, and all attempts, however abortive, to attain the object, serve to strike out new paths, which must, sooner or later, terminate in its real attainment or force its abandonment, leaving at least the legitimate field of research more fertile and better defined. The circumstances of steam power having been a subject of frequent and serious investigation during the period of two thousand years, and, after having been abandoned innumerable times as hopeless, becoming at last triumphant, is most encouraging to those who may be engaged in a research affording such rich prospects as the application of electro magnetism.

It is not much more than twenty years since the connection between electricity and magnetism was decisively verified by experiment, although such a connection had long before been imagined to exist, yet, within that short period, rapid advancement has been made in its application to useful purposes. The electro-magnetic telegraph, by which intelligence might be communicated from one extremity of Britain to another in the twinkling of an eye, is among the fruits of recent labors in this field of research, and, so far as trials have been made, the hope is not excluded that this new agent may yet become a powerful rival to steam. In point of safety its superiority is unquestionable, but it remains to be determined whether or not sufficient power can be obtained on equally economical conditions. The machinery requisite will, from the nature of power, be extremely simple in its construction and moderate in cost, rotatory motion being directly obtained, and the methods of reversing, accelerating, retarding, and terminating the motion requiring no additions which can materially detract from the original power communicated. The simplicity of the machinery also precludes the possibility of much friction, which it is well known absorbs no small portion of the power even of the best constructed steam engines. The great difficulties to be overcome are connected with the batteries, the materials of which stand in the same relation to the electro-magnetic machine that the fuel and water employed in working a steam engine do to that machine. Within the last few years great improvements have, however, been made in the construction of voltaic batteries, the augmentation of their power in proportion to their size, the permanency and equability of their action, and the economization of the materials employed in exciting them. The physiological, chemical, and mechanical effects which could be produced by batteries of a given quantity of surface not above six years ago can now be equaled by the action of batteries of a tenth part the size.

This holds out very great encouragement to those who are engaged in the important task of applying electro-magnetism as a prime mover. After the discovery that a bar of soft iron having an insulated copper wire coiled round it became highly magnetic upon connecting the two ends of the wire with the opposite poles of a galvanic battery in action, the idea seems to have occurred to many scientific and practical men that a new an effective motive power was at their command. In December, 1832, Dr. Schulthess delivered a lecture before the Philosophical Society of Zurich in which he asks "whether such a power as that which is obtained by interrupting the electric current and then restoring it could not be applied with advantage in mechanical science?" And in January, 1833, he exhibited before the Mechanics' Society a machine in which this had been, so far, accomplished. In November, 1832, Salvator Dal Negro, Professor of Natural Philosophy in the University of Padua, published a paper in which he explained the method adopted by him of applying electro-magnetism to move machines. Professor Jacobi, in the introduction to his memoir on this subject, states: "I had the honor in November, 1834, to lay before the Academy of Sciences, of Paris, a note upon a new electro-magnetic apparatus. That note was read at the meeting of December 1, and an abstract of it was printed in the institute, No. 82, of December 3, to which I refer. Since that MM. Botto and Dal Negro have claimed the priority of the invention. The competition in which I find myself engaged with such distinguished men serves only to confirm my conviction of the importance of this new motive power." Jacobi continued his investigations with the utmost industry, and in 1838, under the auspices and at the expense of an imperial commission, he tried the grand experiment of impelling a boat by the agency of electro-magnetism. The vessel was a ten-oared shallop, equipped with paddle-wheels, to which rotatory motion was communicated by an electro-magnetic engine. In general there were ten or twelve persons on board, and the voyage was continued for entire days. The difficulty of their managing the batteries, and the imperfect construction of the engine, were sources of frequent interruption, which could not be well remedied on the spot. After these difficulties were in some degree removed, the professor gives as a result of his experiments that a battery of 20 square feet of platinum will produce a power equivalent to one horse, but he hoped to be able to obtain the same power with about half that amount of battery surface. The vessel went at the rate of four miles per hour, which is certainly more than was accomplished by the first little boat attempted to be propelled by the power of steam. The boat, according to Jacobi, was 28 ft. long and 7½ ft. in width, and drew 2¾ ft. of water. The machine, which occupied little space, was worked by a battery of 64 pairs of platina plates, each having 36 square inches of surface and charged according to the plan of Grove with nitric and sulphuric acid. The boat, with a party of twelve or fourteen persons on board, went against the stream at the rate of three miles per hour. This experiment was tried in 1839, and shows what great progress had been made in the period of about one year, for in 1838, when the same boat was attempted to be propelled by the same machine, it required a battery of about five times the size. These particulars were communicated in a letter to Dr. Faraday by Professor Jacobi, dated 21st June, 1839, and may be seen in the *London and Edinburgh Philosophical Journal* for September, 1839. The publication of this letter called forth one to Dr. Faraday from Professor Forbes, of King's College Aberdeen (dated October 7, 1839), in which, with a laudable desire for the honor of his country, Dr. Forbes gives a detailed account of the progress made by his townsman, Mr. Robert Davidson, in the application of electro-magnetism as a moving power.

At that period Mr. Davidson had in operation by this agent a turning lathe, and a locomotive carriage capable of running with two persons along a coarse wooden floor; and decisive evidence is given that he had been employed for at least two years before in the construction of such machines. He had also made an improvement on Daniell's constant battery, and determined the best kind of iron for electro-magnetic purposes. The expense of these experiments was entirely defrayed by Mr. Davidson himself, and although Dr. Forbes endeavored to impress railway proprietors with the importance of aiding Mr. Davidson with the means of prosecuting his valuable and costly experiments, he was suffered to toil on till of late chiefly at his own risk. Last winter he exhibited in Edinburgh a saw mill and turning lathe, a printing press and locomotive engine, all worked by electro-magnetic power.

In this general sketch of the attempt to employ this new agent as a prime mover, it would be unpardonable to omit noticing the spirited efforts which have been made in the United States. So early as 1836, Mr. Devenport, then a blacksmith in Philadelphia, had turning lathes in action by this power; and in his noble determination to "go ahead" he commenced on January 18, 1840, a newspaper entitled *The Electro-Magnetic and Mechanics' Intelligencer.* This paper, published at New York, was printed by a press worked by an electro-magnetic engine. We give from it the following extract:

"The first number of the *Electro-Magnet* was published on Saturday, January 18, 1840, and was the first paper ever printed by the power of electro-magnetism. The project was proposed and set on foot for the express purpose of bringing before the public some tangible illustration whereby the power might be brought forward upon as cheap and prudent a scale as possible, the question having been so often asked, 'Why don't you apply the machine to this or that?' or anything that they in their wisdom might fancy, all of which we have duly considered. Therefore in following our own inclination, we have commenced as our own judgment dictates, and now offer to the public our plan of operation. As the second number of our publication is now before the public, we would respectfully call the attention of those who would wish to advance the cause of philanthropy, to come forward and assist us in our experiment. That we may be considered chimerical by many we doubt not, but when all things are fully proved we shall hope for a better fate than many of our predecessors."

Captain Taylor, of America, obtained a patent for an electro-magnetic engine in the United States, in 1838, and in England he patented the same engine on November 2, 1839. An account of this engine, accompanied by a drawing of it, may be seen in the *London Mechanics' Magazine*, vol. xxxii., p. 694, and a working model of it is now exhibiting in the Coliseum, London, where it is employed in turning articles in wood, ivory, and metal. Captain Taylor's machine is extremely similar to Mr. Davidson's working models, constructed about the same, if not at an earlier period. The method of cutting off and renewing the electric current is precisely the same. Much information relative to the principles upon which such machines ought to be constructed may be obtained from Jacobi's Report on the subject laid before the Academy of Sciences, St. Petersburg, June, 1838, an abridgment of which may be seen in the report of the meeting of the British Association at Glasgow, in September, 1840.

It was only of late, as already remarked, that Mr. Davidson received any pecuniary aid in the prosecution of his interesting experiments. The Royal Scottish Society of Arts voted him last winter a few pounds to be employed in determining certain points connected with electro-magnetic machines; and several gentlemen undertook to defray the expense which might be incurred in the construction of a railway carriage capable of being propelled by the agency of electro-magnetism. This gave rise to the large and massive carriage which was last September tried on the Edinburgh and Glasgow line. As a description of this vehicle may be interesting to mechanics and engineers generally, I feel gratification in being able to supply it, and hope that, though brief, it will be sufficiently plain, accompanied, as it is, by illustrative diagrams. Those who have attempted the propulsion of machinery by electro-magnetism have proceeded on two plans somewhat different. It is well known that magnetic poles of the same name repel each other, and that those of an opposite name attract each other. Making use of this principle, then, suppose N (Fig. 1) the north pole of

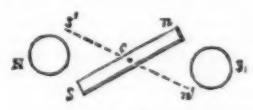


FIG. 1.

a magnet, and S the south pole (they may either be the poles of the same magnet of a horseshoe form, or the N. and S. poles of two different magnets), and let *s n* be a magnet free to move on its fixed center, *c*; *n*, its north pole, will evidently be attracted by *s*, and *s* by *n*, so that the magnet, *s n*, will move in the direction in which it is attracted, and by its momentum or moving force will be carried beyond the points of attraction, S N, nearly into the position represented by the dotted line, *n' s'*. Now suppose that the instant it attains the position, *n' s'*, its polarity is changed, then *s'* will be repelled by S and *n'* by N; and the same conditions recurring, the magnet would evidently be rapidly carried round by the successive attractions and repulsions to which it is subjected. N and S are supposed to be the poles, not of permanent, but of an electro-magnet, that is, an iron bar rendered magnetic by being coiled round with insulated copper wire, the two ends of which are connected with the opposite poles of an excited voltaic battery. The amount of magnetic power depends chiefly on the kind of iron, number of coils of wire, the size of the battery, and the strength of the liquids employed to excite it. Masses of soft iron have been rendered so strongly magnetic as to support more than two tons. The bar, *n s*, is also supposed to be an electro-magnet, and its polarity may be reversed each time it passes the poles, N S, by a very ingenious contrivance of the late Dr. Ritchie, of the Royal Institution, London. To explain this we cannot do better than introduce the diagram of an apparatus in which Dr. Ritchie's plan of reversing the poles is made use of. It consists essentially of a cylinder of soft iron, having a copper wire, covered with thread, coiled round it (Fig. 2), the ends of which terminate in two cups, *c c*. If the wires, Z C, from the opposite ends of a voltaic battery in action be inserted into the cups, *c c*, in contact with the other wires which terminate them, a current of electricity will pass along the coil and induce magnetism in the inclosed cylinder of iron. By similar means, the rod of soft iron, *n s*, which is intended to revolve, is rendered magnetic, and we have now to direct attention to the manner in which its poles are successively reversed. It is well known that a vessel may be rather more than filled with a liquid; that the liquid may be heaped up in it, assuming a convex surface, until the adhesion of the liquid particles is overcome by the force of gravitation. Taking advantage of this principle, Dr. Ritchie filled a cup, D, so that the ends of the wires proceeding from the coil on the revolving bar, *n s*, might almost touch the partition, *p p*, which is made of a non-conductor of electricity, and divides the cups into two compartments, *a b*. The compartments are heaped up with mercury, the partition being left uncovered, and connected to the opposite ends of a voltaic battery by the wires, P and K, so that the one compartment may be viewed as the positive end of the battery and the other as the negative end. When the bar, *n*

* From an article in the *Practical Mechanic*, Vol. II., 1843, entitled "Prospects of Electro-Magnetism as a Prime Mover, with a Notice of Mr. Robert Davidson's Electro-magnetic locomotive, lately tried on the Edinburgh and Glasgow Railway," by David Mackie, C.E., etc.

s, is in a straight line with the poles, N S, the ends of the wires from it are immediately above the partition, and, consequently, there is no current of electricity along the coil; but the moment the bar is moved to one side so as to make the wires dip into the mercury, and thus connect them with the opposite ends of the battery, a current of electricity passes along the helix on *n s* and renders it magnetic. N repels *n*, while S repels *s*, and the bar moves round till N comes within the sphere of the attraction of S, and *s* within the attraction of N. The bar moves round until the wires are again out of the mercury, being above the partition, but in opposition to their former order. That instant the bar is demagnetized, and the next the wire formerly in *a* passes into *b*, and that in *b* into *a*, becoming again connected with the battery, but so as to send the electric current in the opposite direction and reverse the polarity of the bar. Instead of using only one fixed electro-magnet, it is evident that more might be used, and the revolving bar be thus subjected to a greater number of alternate attractions and repulsions. And should it be required to reverse the motion of the bar, we have only to make the wires, P and K, change places with

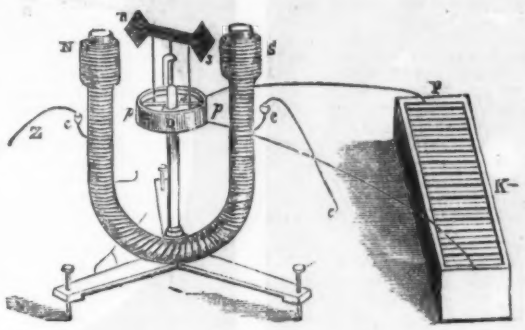


FIG. 2.

respect to the ends of the battery. Such is the manner in which rotatory motion is produced, sustained, and modified in one class of electro magnetic machines. At first view it would strike one that greater power could be obtained by using both the attractive and repulsive forces than by employing the attractive alone, yet Captain Taylor and Mr. Davidson, who have certainly paid much attention to the subject, seem to be of a different opinion, as they have adopted the latter method in all their machines.

They make use of electro-magnets to drag round masses of unmagnetized iron, contriving to deprive the magnets of their power, immediately after a mass has reached them, and again enduing them with power whenever a mass comes into a position favorable to its being attracted in the proper direction. What we have to premise, however, before giving an account of the construction of Mr. Davidson's electro-magnetic locomotive, will serve to render this plainer. As we do not think that the most complete drawing of the machine, unless it were of enormous size, could make the construction and mode of action so easily understood as references to diagrams explaining in detail the principles of its movements and their modifications, we shall adopt this mode of procedure.

Let there be a wooden cylinder (Fig. 3) of convenient diameter, and free to move on its axis, and let 1, 2, 3, represent the ends of masses of iron grooved into it, and M *m* two pieces of iron which we have the power of magnetizing or

FIG. 3.

demagnetizing at pleasure. In the present situation of the cylinder suppose M to be magnetic, while *m* is not so, then M will evidently attract 1 more than 2; consequently 1 will be drawn toward M, carrying the cylinder round in that direction If when the middle of 1 has arrived very near the middle of M the magnetism is destroyed and *m* indued with magnetism it will attract 2, which by that time will be within its sphere of attraction. It is true that when 1 is immediately opposite M, 2 and 3 will be equally attracted by *m*, but then the momentum which the revolving mass has acquired acts in conjunction with the force by which 2 is drawn toward *m*, so that the motion is continued in that direction; and as 2 approaches *m* the attractive force is rapidly increased, while that of *m* for 3 is proportionally diminished. By these means rotatory motion may be communicated to wheels the axle of which passes through the middle of the revolving cylinder. The next inquiry is, how are the bars M *m* to be magnetized and demagnetized at the instants required? Knowing that a bar of soft iron is rendered magnetic in virtue of a current of electricity passing along the wire with which it may be coiled, and that whenever that current is by any means broken the iron is no longer magnetic, it becomes necessary to fall upon some method of breaking the line of conduction and renewing it at will. Dr. Ritchie's method is beautiful and highly ingenious, but in applying electro-magnetism to the propulsion of boats or carriages it would not suit, as the mercury would be too much shaken, and sometimes even thrown out of the compartments of the cup or trough. Of course the method adopted in class experiments might be resorted to; that is, a person might be employed to break or complete the contact as the case might require, just as boys were formerly employed to open and shut the steam and injection cocks in Newcomen's engine. The beautiful contrivance of self-acting valves which now supersedes that irksome task is, perhaps, surpassed, at least in simplicity by the method fallen upon by Captain Taylor and Mr. Davidson, of letting on and taking off the electric current, if we may be allowed this mode of expression. By means of the annexed diagram we shall be enabled to explain this contrivance, and, indeed, almost the whole that requires explanation in connection with this class of electro-magnetic engines. Let M and M′ (Fig. 4) represent two electro-magnets, by means of which rotatory motion is to be given to the cylinder between them, furnished with masses of iron, as formerly described. Near each end of the axle which passes through the large cylinder are two smaller cylinders. Each of these cylinders has the half of its rim next to the larger cylinder entirely covered with metal, so that it is a conductor of electricity. The outer halves, O O′, are only partly covered with metal, the intervening portions being of ivory, well baked wood, or some other non-conductor of electricity. We shall suppose the dark spaces on the belts, O O′, to represent the conducting parts, and the white spaces the non-conducting parts. Now, suppose one end of the wire which is coiled round the iron, M, to be connected to Z, one pole of a battery, and the other end of that wire, *a*, to rest on *c*, the metallic rim of the right hand small cylinder, while the wire, K *b*, from the other pole of the same battery rests on a metallic part of the rim, O; in this case the circuit is complete. From the end, Z, of the battery the electricity traverses the coil and the other connecting wires in the direction pointed out by the arrows; for the ends of the wires, *a b*, though not in contact, rest on the same metallic surface. M is, therefore, an electro-magnet (in virtue of the current of electricity traversing its coil), and will be acting on one of the iron masses fixed on the large cylinder. By directing attention to the position of the wires, *e d*, on the opposite small cylinder, it will be seen that *e* rests upon a non-conductor, so that the electricity cannot pass from *d* to *e*, or the current, which would otherwise traverse the coil on M′, is interrupted, and consequently M′ is not magnetic. As the cylinder revolves, *e* and *d* will at length both rest on the same conductor, and M′ will be magnetized; while, at the same time, a non-conducting part of the opposite cylinder will have reached *b*, and M will lose its attractive power. Such is the very simple manner in which the voltaic currents which traverse the coils are interrupted and renewed in order alternately to demagnetize and magnetize the inclosed nuclei of soft iron.

After the above details we trust that no one can fail to understand thoroughly the nature and construction of Mr. Davidson's electro-magnetic locomotive, a general representation of which is given (Fig. 5). The two batteries at the front of the carriage serve to communicate power to the four large electro-magnets nearest to them. A pair of these magnets is placed on each side of the large cylinder, through the middle of which the axle of the front wheels passes. The pair on the right and the pair on the left of the large cylinder act alternately on the masses of iron grooved into that cylinder, and communicate motion to the front wheels, the magnets receiving and being deprived of power in the manner already described. By the very same means, as the drawing indicates, motion is communicated to the hind wheels of the vehicle and locomotion insured. The cylinders on which the arrangement is made for breaking and renewing connection with the batteries are, in Mr. Davidson's carriage, on the axles, beyond the wheels of the carriage; but we should think that, as they are a nice and important part of the apparatus, they would be safer within the wheels.

There are some points connected with the construction of separate and important parts of the vehicle which require notice; and, first, of the batteries. These are formed of pairs of iron plates, with an amalgamated plate of zinc interposed between each pair—a description of battery which Mr. Sturgeon, in 1829, found to be superior, in point of economy and action, in all cases where quantity without high intensity is required. The plates are 15 inches deep and 12 inches broad. There are four batteries, two at each end of the carriage, in all containing 40 zinc plates. Each battery is arranged so that it can be raised from its wooden trough, or sunk in it, by means of a wheel and axle fixed in a frame above. The original extent of battery surface amounted to what we have mentioned, but Mr. Davidson finding it insufficient, mounted an additional battery on each side of the carriage on the part of the platform between the wheels.

These batteries have 19 pairs of iron plates, with zinc ones intervening, all of the same size as in the former batteries. When the carriage was tried on the Edinburgh and Glasgow Railway, the whole of the batteries were put into action. The carriage is 16 ft. long and 6 ft. broad, and weighs above 5 tons, including batteries, magnets, etc The rate of motion was about 4 miles per hour. The engineer will easily see that a fraction of a horse-power was all that was requisite to produce this effect on a level railway, and from knowing the work done by some of Mr. Davidson's smaller machines, we anticipated a much greater velocity with such an extent of battery. It is, however, among the first experiments on a grand scale, and we have no doubt will in time lead to much more gratifying results.

The electro-magnets are not one solid piece of iron, as is generally the case, neither are they rounded behind. Each of the side parts or arms is constructed of four plates of soft iron, put together so as to form, as it were, a box, for the sake of lightness. These arms are 25 inches long, and joined together behind by plates of iron. Their rectangular poles measure 8 inches by 5 inches long, and at their nearest points are only about 4 inches asunder. The coils with which they are surrounded do not consist of a single copper wire, but of bundles of wire wrapped round with cloth to insure insulation. According to Mr. Davidson's first arrangement, these magnets were placed so that their poles were nearly in contact with the revolving masses of iron in their transit; but so prodigious was the mutual attraction, that the means taken to retain the magnets and iron in their assigned positions were insufficient. They required to be more firmly secured, and their distances had to be somewhat increased, by which considerable power was lost. The result of Professor Jacobi's experiments on the water, and of Mr. Davidson's on the railway, will, no doubt, disappoint the exaggerated expectations of some who may view them as rather unfavorable to the claims of electro-magnetism, but it must be kept in mind that it is only a few years since it in any degree engaged attention as a means of obtaining mechanical power, and, indeed, it could not have done so earlier, the connection between electricity and magnetism being so very recent a discovery.

Should it ever lead to the results anticipated from it as a prime mover, there are many advantages which it will possess over steam. The clash, din, and concussion occasioned by steam engine machinery, the dread of explosions, and the smoke, dust, and danger of fire would all be got rid of. The only noise in an electro-magnetic locomotive or boat

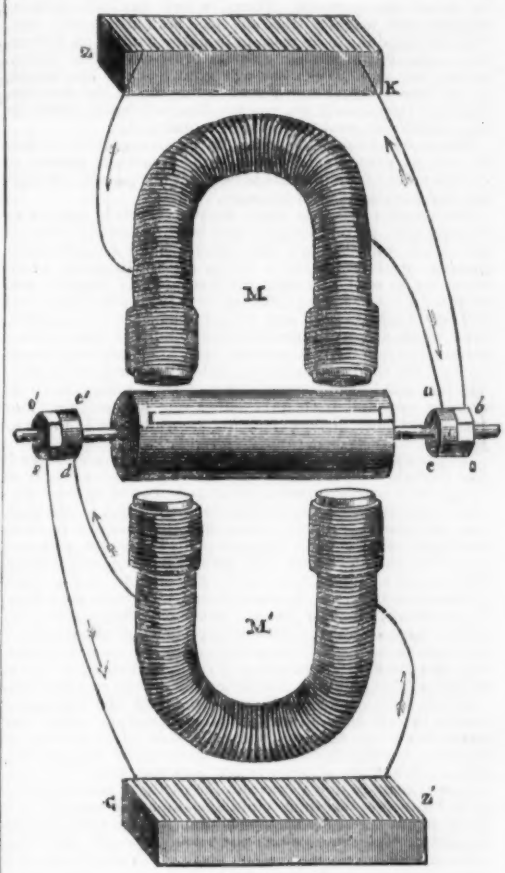


FIG. 4.

would be that of the wheels, and the batteries could be charged in such a manner as to avoid all disagreeable smell. But even if the method of exciting them should be such as to produce hydrogen gas, this, instead of being permitted to escape and annoy passengers, could be collected and rendered available as a means of producing light and heat when required. So far, however, as light is concerned it could be obtained otherwise at no additional expense; for a piece of charcoal being interposed at a small breach in the wires connected with the batteries would by its ignition afford the most intense and brilliant light imaginable, and furnish the means also of communicating signals to an immense distance.

We are inclined to think that the application of this new prime mover to navigation, particularly on the ocean, holds

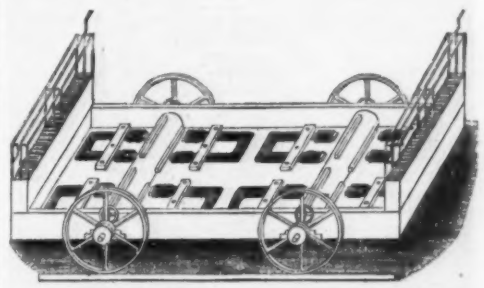


FIG. 5.—DAVIDSON'S ELECTRO-MAGNETIC LOCOMOTIVE.

out better hopes of success than its application to locomotives on land. Iron vessels have now been proved well adapted for duty at sea, and since that metal and salt water constitute two important elements of a voltaic battery, may some means not be suggested of introducing the third element, so that a great part, if not the whole, of the surface of the ship may be called into action for the purpose of furthering her progress, thus making the ocean, so far, her propeller as well as support, while her own body also performed two important offices? Much less weight would also require to be carried by an electro-magnetic boat than by a steamer, and she could, therefore, undertake much longer voyages.

ELECTRIFIED LILY.—During a storm at Montmaurin, in the upper Garonne, M F. Laroque witnessed a curious electric phenomenon. Looking toward a clump of lilies, he saw the highest plunged in a diffused violet light, which formed an aureole around the corolla. This light lasted for eight or ten seconds. After it had ceased, he approached the lily, which he found, to his great surprise, wholly deprived of its pollen, while the neighboring flowers were covered with it.—*La Nature.*

VENUS NEARING TRANSIT.

THE planet Venus is not only interesting just now because of the approaching transit of the planet across the face of the sun, but also as the ruling star of eve. Her movements at present are such that she appears to be gradually increasing her distance from the sun, attaining her greatest elongation (east) from him on September 26, at one in the afternoon, at which time she will be separated about 46° 31', or 1° 31' more than half a right angle from him. But after that time she will draw gradually nearer and nearer to him on the heavens (it must be clearly understood when we speak of the distance of Venus from the sun increasing and diminishing, that we are not referring to actual distance, but to apparent distance in the sky). During the first five weeks or so of this approach, Venus, which has been growing brighter and brighter since she has been an evening star, will still continue to increase in brightness until, on November 1, she will attain her greatest brilliancy, after which, during five more weeks, she will grow less and less bright, as she draws nearer and nearer to the sun in the heavens, until, on December 6, she reaches him, and passes across his face toward the west to become a morning star.

Before considering the transit of Venus especially, it may be well, as Venus is the planet of the evening at present, to consider her as she presents herself at each passage through her various phases of appearance.

For rather more than eight months Venus is seen as an evening star, getting brighter and brighter slowly, for the first seven months, and then getting fainter much more quickly, until at last she is lost to sight. In about a fortnight she is seen as a morning star, getting brighter and brighter quickly during rather more than a month, and then getting slowly fainter and fainter during seven months, after which she can no more be seen. So that Venus shines about eight months as a morning star; after this remains out of sight for about two months, and is then seen as an evening star; and so she goes on changing from a morning to an evening star, and from an evening star to a morning star continually, and always changing in brightness in the way just described.

Venus was called of old the Planet of Love; and when it was thought that the stars rule our fortunes, the rays of Venus were supposed to do a great deal of good to those who were born when she was shining brightly. But in our time, men of sense reject the notion that because a star looks beautiful, like Venus, it brings good luck; or that because a star looks dim and yellow, like Saturn, it brings bad fortune. They know that Venus is a globe like our own earth, going round the sun just as the earth does. Our earth seen from Venus looks like a star just as Venus looks like a star to us. And if there are any creatures living on Venus who can study the stars as we do, they have quite as much reason for thinking that the globe on which we live brings them good luck, as we have for thinking that *their* globe brings *us* good luck.

Of all the stars we see Venus is the only one which is in reality like the earth in size. All the others are either very much smaller or very much larger. Most of them—in fact all the stars properly so called—are globes of fire like our sun, and are thousands of times larger than the globe we live on. A few others are like Venus and the earth, in not being true stars but bodies traveling round the sun and owing all their light to him. But it so happens that not one even of these is nearly of the same size as the earth; they are all either very much larger or very much smaller. Venus is the only sister-world the earth has, among all the orbs which travel round the sun. There may be others in the far-off depths of space, traveling round some one or other of those suns which we call "stars," but if so, we can never know that such sister-worlds exist, for no telescope could ever be made which would show them to us.

And as Venus is the earth's sister-world, so is she her nearest neighbor, except the moon, which is the earth's constant companion. The globes which form the sun's family go round him in paths which lie nearly in the same level. Venus is the second in order of distance, our earth the third, and Mars the fourth (Fig. 1). So that Mars is our

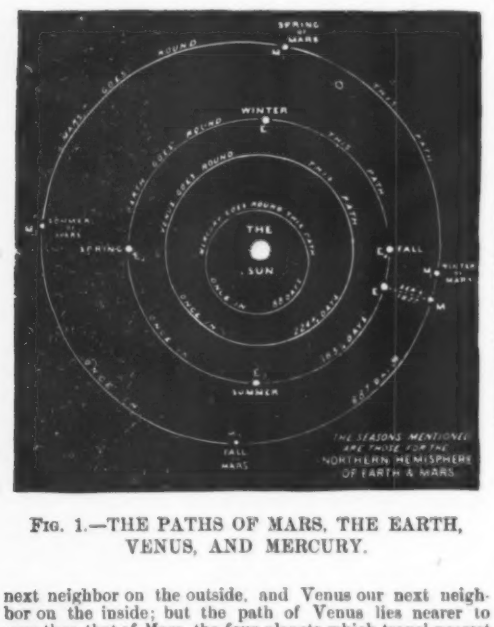


FIG. 1.—THE PATHS OF MARS, THE EARTH, VENUS, AND MERCURY.

next neighbor on the outside, and Venus our next neighbor on the inside; but the path of Venus lies nearer to ours than that of Mars, the four planets which travel nearest to the sun.

But it will be convenient for us to consider at present only the paths of our earth and Venus.

Fig. 2 shows the shape and size of the paths of Venus and the earth, S being the sun, the inside circle (with eight little globes shown upon it) being the path of Venus, and the outside circle the path of the earth. The earth takes a year going round her path, while Venus goes round hers in about seven months and a half, so that just as the two hands of a clock going round at different rates come together at regular intervals, so Venus and the earth come at regular intervals on a line with the sun, as shown at E and V_5 in Fig. 2. But it will be easier to see what changes must happen in the appearance of Venus, if we suppose the earth to stay still as at E, and Venus to go round from the position, V_1, to all the other places, V_2, V_3, etc., shown in the figure. It takes her about nineteen months to get through all these changes. When she is at V_1 she is very far away, as the figure shows. Her bright face—that is, the face the sun shines on—is turned toward the earth full front, and the face she shows is therefore like 1 in Fig. 3. She goes on to V_2, drawing nearer, and turning a small part of her dark half towards the earth; so she looks as 2, Fig. 3. At V_3 she is still nearer, and turns still more of her dark half toward the earth; looking like 3, Fig. 3. At V_4 she turns rather more than half her dark side toward the earth, and looks like 4. At this time she looks much brighter than when she was on any part of the path from V_1 to V_3. But now she draws up to the place, V_5, where her dark side is turned fully toward the earth. Her face is like the horned moon during this part of

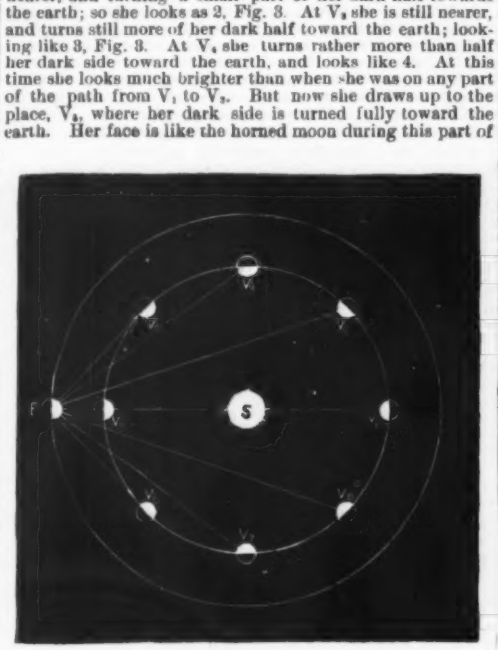


FIG. 2.—THE PATHS OF VENUS AND THE EARTH AROUND THE SUN.

(On the scale of this figure the Sun's diameter would be little more than the thickness of the circles, representing the orbits of Venus and the Earth. Venus and the Earth would be scarcely discernible points.)

her course, but grows larger and larger, until when she is at V_5 it would be as large as 5 in Fig. 3, if it could be seen. But at this time it is out of sight, just as the moon is before she shows as a new moon. Afterward Venus goes through the same changes, but in the reverse order, getting smaller and smaller, but turning more and more of her bright face toward us, as shown at 6, 7, 8, and 1, Fig. 3. Remembering that Venus takes nineteen months in passing through all these changes, we see how it is that for about seven months she gets brighter and brighter as an evening star (this is while she is moving from near V_1 to V_4). She then continues about a month more as an evening star, but growing fainter (while she is moving from V_4 to near V_5). After this she becomes a morning star, growing brighter for a month or so

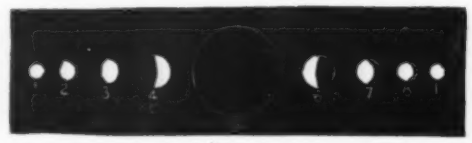


FIG. 3.—SHOWING THE PHASES OF VENUS.

(while she is moving from near V_5 to V_8). And lastly, for eight months more, remaining a morning star, she gets gradually fainter (while she is moving from V_8 to V_1).

When Venus is observed without a telescope she always looks like a bright point of light, because she is so far from us. But with a telescope, even a small one, the changes of shape and size shown in Fig. 3 can be easily seen. They were first seen by Galileo, the great Italian astronomer, in the year 1610. If we could only see Venus's bright face instead of her dark one, when she is nearest to us, we could learn more about her; but as it is, Venus cannot be seen at all when nearest, and the more of her bright face she turns toward us the farther away she gets. Yet we have learned many interesting facts about her, and a few which no one ever could have thought we should learn.

Venus looks very beautiful to us, but our earth must look far more beautiful to creatures living on Venus. For, as is seen from Fig. 2, when Venus is nearest to the earth, and turns her dark side toward us, the earth turns her bright face to Venus. If Venus looks so bright as she does when only turning toward us a small half-face like 4 or 6 (Fig. 3),

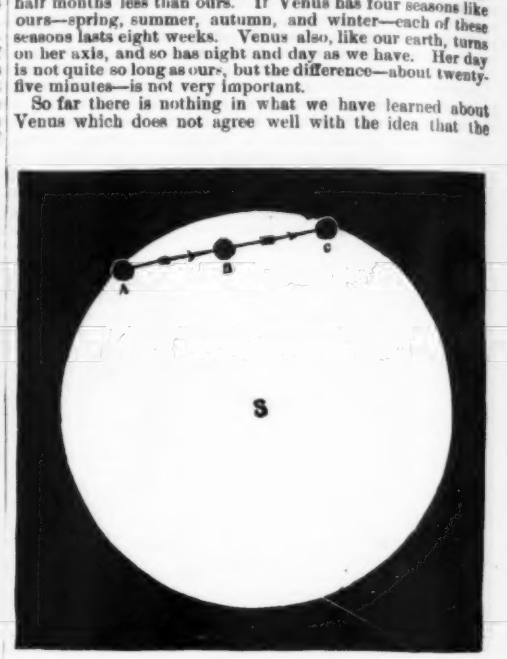


FIG. 4.

and when shining on a bright sky, how glorious must the earth appear when turning a bright disk as large as 5 (Fig. 2), toward Venus, and shining on a black sky? For observe: when Venus is at V_5, Fig. 1, the earth, E, is on that side of her which is just opposite the sun. The earth is therefore seen at midnight. So that, beautiful as our sister-world looks to us, our own world looks still more beautiful to Venus. It shines at midnight in her sky as a star far brighter than our star of morning and evening, and close by it the moon must be quite clearly seen, now on one side, now on the other. One cannot but wonder whether there are creatures on Venus who admire this beautiful sight in their skies, or try to find out if that distant world, our own earth, is the abode of living creatures.

Let us now consider what this star really is, so far, at least, as we can learn by using telescopes and other instruments.

Venus has, in the first place, been measured, and we find that she is a globe nearly as large as the earth. Like the earth, she travels round and round the sun continually, but not in the same time as the earth. The earth goes round the sun once in twelve months while Venus goes round once in about seven-and a-half months; so that *her* year, the time in which the seasons run through their changes, is four and-a-half months less than ours. If Venus has four seasons like ours—spring, summer, autumn, and winter—each of these seasons lasts eight weeks. Venus also, like our earth, turns on her axis, and so has night and day as we have. Her day is not quite so long as ours, but the difference—about twenty-five minutes—is not very important.

So far there is nothing in what we have learned about Venus which does not agree well with the idea that the planet is a world like our earth, where people like ourselves might live very comfortably. For it would not matter much to us, probably, if the year were shortened by four or five months, and the day by half-an-hour—supposing always that trees and vegetables were so made that they could thrive under the change. In fact, if any one leaves the temperate regions to visit the tropics, he has to undergo a greater change. For in England, and throughout the United States, the seasons change from the heat of summer to the cold of winter, and back again to the heat of summer, in twelve months; but at the equator, the greatest heat occurs in spring and autumn, or at intervals of only six months. So far as the length of the year is concerned, an American or an Englishman could very well bear the change to the temperate zone of Venus, where the interval between the successive seasons of greatest heat amounts to seven-and-a-half months.

But when we consider some other points, we see that Venus, beautiful though she looks, would not be a comfortable home for us. Venus is much nearer to the sun—the great fire of the solar system—than our earth is. She receives, then, much more heat from him. In fact, it is easily calculated that if our earth were set traveling on the path of Venus, we should receive almost exactly twice as much heat from the sun as we do at present. This would be unbearable, except, perhaps, in the Polar regions; and even there the summer, with that tremendous sun above the horizon all through the twenty-four hours, would be scarcely bearable. Besides, what a contrast between the hot Polar summer and the cold Polar winter, when for weeks together the sun would not be seen at all. Altogether, this earth would be a miserable home for us if her path were as close to the sun as that of Venus.

We see, then, that either there must be some peculiarities about Venus which prevent the sun from heating people there as he would certainly heat us if our home were there, or else the creatures which live on Venus must be different from ourselves and the other animal inhabitants of our earth. Unfortunately, we cannot make telescopes large enough to show us what is going on upon that planet, and there is no reason for hoping that such telescopes can ever be made. What we know, however, about the planet's condition does not seem to show that creatures living there would be more comfortable than we should be if the earth were put where Venus is. Just the contrary, so far as we can judge. The seasons on our earth are caused by the fact that she turns on a slanted axis. If her axis were upright, there would be no seasons; if it were more slanted, the contrast between summer and winter would be greater. Now Venus has her axis much more slanted than the earth's, so that her seasons must be very marked indeed. Thus the heat of her summer weather must be even more terrible than if her globe were inclined like the earth's.

But there is yet another point to be noticed. On the upper slopes of lofty mountains, there is snow all the year round, even in the torrid zone. That is because the air up there is so rare that it does not act like the denser air lower down, which is a sort of clothing for the earth, keeping the heat from escaping. Now if the air of Venus were very rare, something of the same sort might happen on that planet. Just as people who live in torrid zones seek the high mountain slopes in the hottest seasons of the year, and find there a temperate climate, so the inhabitants of Venus might find it possible to bear the sun's intense heat if the air of the planet were rare like that above the snow-line in our mountain regions.

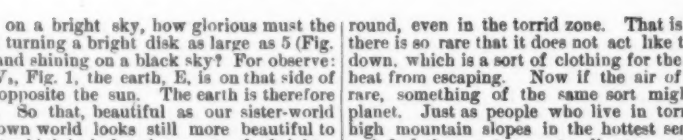


FIG. 5.

But it seems that, on the contrary, the air of Venus is even denser than ours. And it seems also to be a moist air, which is just the kind of air that keeps the heat in most. The air of Venus is, in fact, so dense and moist that the planet would be very uncomfortable (quite apart from the intense heat) for creatures like ourselves.

The density of the air of Venus has been shown in several ways. Perhaps the most satisfactory proof is that which was obtained during the last transit of Venus across the sun's face on December 9, 1874.

On that occasion, when the planet traversed such a path as is shown in Fig. 4, a phenomenon of great physical interest and importance was observed.

When the planet was at A, entering on the sun's face, a bright arc of light was seen round the part of the planet which had not yet entered upon the sun's face. This arc was not a mere faint light, but strong sunlight, as bright as that derived directly from the sun's disk. When the planet was at C, a similar arc of light was seen as shown in Fig. 4. There is only one way in which this arc of light can be accounted for, and that is by the action of air upon Venus, bending the sun's rays, as shown in Fig. 5, so that the sun is seen *round the corner*. Our air shows us the sun in this way, when he would be quite out of sight if there were no air; for when we see the sun's disk just touching the horizon, it is the air which really brings him into view, by bending his rays round the curved surface of the earth.

So we are quite certain that there is air of some kind on Venus. And we can even tell how much there is. Professor Lyman, of Yale College, America, has made observations of this kind (not exactly the same as are illustrated in Fig. 5, but depending upon the same bending power of the air on rays of light); and from what he has seen, it appears that the air on Venus is about twice as dense (at the planet's surface) as the air on the earth.

Remembering that the sunlight has passed through this air, we can understand that the light which comes to us as in Fig. 5 may tell us what sort of air it has passed through. The spectroscope can tell as certainly—though the observation is, of course, more delicate—that it has passed through the vapor of water in the air of Venus, as the rainband spectroscope on our own earth can tell us of the presence of aqueous vapors in our air. That is what astronomers learned in December, 1874, when the globe of Venus was passing, as in Fig. 4, between our earth and the sun.

There cannot be moisture in the air of a planet unless there are seas and oceans on the planet's surface. No doubt, then, Venus has her continents and oceans, her islands and promontories, and inland seas and lakes, very much as our earth has. Then there must be rivers on the land, and currents in the ocean; there must be clouds and rain, wind and storm, thunder and lightning, and perhaps snow and hail.

Whether the planet is an inhabited world or not, it would be difficult to say. Perhaps it is a world getting ready for use as a home for living creatures. Most physicists believe that the sun is gradually parting with his heat. If, millions of years hence, the sun should only give out half as much heat as he does, Venus would be as comfortable a place to live in as our earth is now. But at present it may safely be said that if Venus is inhabited, it must be by creatures very different from those inhabiting the earth.—*R. A. Proctor, in Knowledge.*

PUBLIC HEALTH.*

It has been long known, in many of those diseases which we term infectious or contagious, that by separating the individual attacked from the community, we may check the spread of the disease, and this practice has long prevailed.

The recent valuable and interesting report by your able medical officer of health, Dr. Armstrong, illustrates how the spread of scarlet fever and typhus has been checked, in this town of Newcastle, by the isolation of cases by removing them to hospital; and how careful and systematic vaccination has secured immunity from the scourge of smallpox.

In some towns, the local authorities have obtained power to compel the registration of all cases of infectious diseases within their jurisdiction. But it is very difficult effectively to isolate a patient in his own home; hence the further question arises as to what arrangements should be adopted for insuring to the public the best means of isolation.

Special hospitals have been the panacea proposed; but a suspicion has recently arisen that if all cases of infectious diseases are concentrated in a special hospital in an inhabited district, this concentration of disease may have tended to intensify the disease, and disseminate it in the neighborhood.

Under the circumstances of the existing law, we must mainly trust to voluntary effort to prevent the spread of infectious disease; and I may here quote the experience of a nurse of twenty years' experience, in dealing with the most infectious and dangerous of these diseases, viz., scarlet fever. Her chief practice was the common one in respect to all cases of the various epidemics—to isolate the patient in a single room, the upper room if possible, and let no one else enter it; to so arrange as to keep the door and part of the window open, in order to let a current of air pass through the room over the patient; to observe all the details of regulations as to the cleanliness of the patient and the articles of clothing and furniture, and the removal of excreta, etc.; and as to her own personal protection, never to drink out of the same vessel that had been used by the patient, and especially to wash from head to foot twice a day with tepid water, and to change her clothes each day; moreover, she was careful never to serve in conditions of exhaustion with an empty stomach. With these precautions, she had never had a single case of the spread of the disease to a member of the family or any one else during the twenty years; nor had she once contracted the disease herself.

Notwithstanding the numerous experiments, and the great efforts which have been made in recent times to endeavor to trace out the origin of disease, the sanitarian has not yet been able to lift up the veil which conceals the causes connected with the occurrence. These diseases come in recurring periods, sometimes at longer, sometimes at shorter intervals. Animals, as well as the human race, are similarly affected by these diseases of periodical recurrence; but why they prevail more in one year than in another we are entirely ignorant. They appear to be subject to certain aerial or climatic conditions. Cholera affords an illustration of this.

There is a part of India, low-lying, water-logged, near the mouth of the Ganges, where cholera may be said to be endemic. In certain years, but why we know not, it spreads out of this district, and moves westward over the country; the people are sedentary, and seldom leave home, but the cholera travels on. At last it arrives on the borders of the desert, where there are no people, and no intercourse, no alvine secretions, and no sewers, yet the statistician sitting in Calcutta can tell almost the day on which the epidemic influence will have crossed the desert. But it exercises discrimination in its attacks. It will visit one town or village, and leave many others in the vicinity untouched. Similarly, it will attack one house and leave another. But it has been generally found that the attacked house or village held out a special invitation from its insanitary condition. The same houses or the same localities will be revisited in recurring epidemics, because the conditions remain the same; remove those conditions, and at the next recurrence the locality will escape.

At Malta it was found that the same localities and houses which yielded the majority of plague deaths there in 1813, yielded the majority of the deaths in the cholera epidemics of 1837 and 1867; and that in the intervals the same localities yielded the majority of cases of small-pox, fever, and of an anthrax, a very special eruptive epidemic attended by carbuncles.

Hence, while we are unable either to account for the cause, or to prevent the periodic recurrence of epidemic diseases, the sanitarian has learned that it is possible to mitigate the severity of the visit; and that whether these diseases arise from the occult causes to which I have alluded, or from other causes, pure air and pure water afford almost absolute safeguard against most forms of zymotic disease.

Water has for many years been the subject of careful examination and analysis; indeed, in the water supply for our large towns water examination may be said to be an ordinary branch of the service. So long as the country was sparsely inhabited, the question of the pollution of rivers was comparatively unimportant, because when sewage is discharged into running water, provided the primary dilution of the sewage with pure water be sufficient, the removal of the organic impurity will be effected after the run of a certain number of miles, the precise distance of travel being dependent on several conditions. Perhaps the most beautiful instance of the self-cleansing power of a river is afforded by the Seine at Paris, where the river, which is black and foul when it leaves the town, becomes comparatively clear and full of water plants and fish at some ten or twelve miles lower down. But the numerous centers of population in England, and shortness of the rivers, leave them no time to exercise these self-cleansing processes; and some of the most important sanitary legislation in recent years has been devoted to the preservation of our rivers from pollution. It is, however, shown by Dr. Angus Smith's reports, under the Pollution of Rivers Acts, that either by the application of sewage to land, or by some of the methods of defecation which I will not further enter upon here, water from sewage may be so purified as to be placed in a flowing river without mischief. And although there are many theories as to how far water which has once been contaminated by sewage may again, after a time, become fit to drink, I am disposed to think that there has never been a well-proved case of an outbreak of disease resulting from the use of drinking water, where the chemist would not unhesitatingly, on analysis, have condemned the water as an impure source; and it appears probable that, whatever may be the actual cause of diseases, *i. e.*, whether germs or chemical poisons, the *materies morbi* which finds its way into the river at the sewage outfall is destroyed, together with the organic impurity, after a certain length of flow. Considering the density of population over the whole country, it is to be regretted that so much time has been lost in bringing these acts into operation; and it is to be hoped that there will be no further delay in strictly enforcing the provisions of the Rivers Pollution Act.

With respect to air, the question is somewhat different. It is nearly fifty years ago since that able sanitarian, Mr. Chadwick, impressed on the community the evils which were caused by the impure condition of the air in our towns, owing to the retention of refuse round the houses. In considering this question it is necessary to discriminate. The gases which are the result of putrefaction are offensive to the smell, and some of them, as, for instance, sulphureted hydrogen, are dangerous, in that they may kill people outright if they are present in undue proportions in the air; or, if air containing smaller proportions of these gases be breathed for a long time, the general tone of the individual inhaling them may be lowered, but they do not produce specific diseases. When, however, the putrefaction has gone on for some time, it may result in leading to the development of other conditions which may become the cause of disease, or death.

In connection with this question, M. Gustave le Bon published recently in the *Comptes Rendus* some experiments relating to the properties and the influence of antiseptics on the volatile products of putrefaction. He prepared a liquid made up of water and hashed meat. He placed a frog in an inclosure with some of the liquid. When putrefaction first set in, a very fetid odor was produced and the liquids swarmed with bacteria, and he states that in this condition it is a very virulent poison if injected under the skin of an animal; but the frog, merely breathing the effluvia, took no harm. After two months, the strong fetid odor had much diminished; the liquid had ceased to have virulent properties when injected under the skin, but the animal breathing its volatile products was rapidly killed by them. There is thus no parallelism between the virulent power of a substance in putrefaction and the toxical power of the volatile compounds given off by it; indeed these powers seem to be in an inverse ratio. Moreover, the older the putrefaction, the weaker is the disinfectant power of any antiseptic over it.

These experiments are consistent with the observation that an offensive smell is often less injurious than the lighter fetid odor from an old drain; and that putrefying matter left for a long time in ashpits or manure heaps may be a source of danger; and it is also consistent with the observation that emanations from decomposing matter in the soil, such as refuse in old cesspools, or the stagnant deposit of sewage in badly constructed drains, may produce very dangerous results, although the odor is not strongly offensive, and they justify the established axiom that all refuse matter should be removed as rapidly as possible from the vicinity of dwellings.

There is no doubt that, in the sewering of towns, want of experience in the construction of the works has, in some cases, led to deposits in the sewers, and in consequence of the failure to remove these dangerous gases, evil consequences have ensued; but it may be accepted as certain, that in every case where the sewerage has been devised on sound principles, and where the works have been carried on under intelligent supervision, a largely reduced death-rate has invariably followed.

But while the retention of refuse is probably the most fertile cause of mischief, there are other questions connected with the purity of air to which it is useful to direct our attention. Dr. Angus Smith has given us very valuable information on this subject, in his "Contributions to the Beginnings of a Chemical Climatology." He shows that the air in the middle of the Atlantic Ocean, on the sea-shore, and on uncontaminated open spaces, commands the greatest amount of oxygen; that at the top of hills the air contains more oxygen than at the bottom; and that places where putrefaction may be supposed to exist are subject to a diminution of oxygen. For instance, a diminution of oxygen and an increase of carbonic acid is decidedly apparent in crowded rooms, theaters cowhouses, and stables. It is well known that oxygen over putrid substances is absorbed, while carbonic acid and other gases take its place; and hence all places near or in our houses which contain impurities diminish the oxygen of the air.

Let me explain to you what this diminution of oxygen means. The average quantity of oxygen in pure air amounts to 21 parts out of 100. In impure places, such, for instance, as in a sleeping room, where the windows had been shut all night, or in a lecture theater after a lecture, or in a close stable, the oxygen has been found to be reduced to as little as 20 parts in 100. That is to say, a man breathing pure air obtains, and he requires, 2,164 grains of oxygen per hour. In bad air he would, if breathing at the same rate, get little over 2,000 grains of oxygen an hour, that is a loss of about 8 per cent.; and this diminished quantity of oxygen is replaced with other, and in almost all cases, pernicious matters. The oxygen is the hard-working, active substance that keeps up the fire, cooks the food, and purifies the blood; and, of course, as the proportion of oxygen in the air breathed diminishes, the lungs must exert themselves more to obtain the necessary quantity of oxygen for carrying on the functions of life. If the air is loaded with impurities, the lungs get clogged, and their power of absorbing the oxygen that is present in the air is diminished. An individual breathing this impure air must therefore do less work; or, if he does the same amount of work, it is at a greater expense to his system. In towns, the impurity of air arises chiefly from dust of refuse, mostly horse manure, as well as from smoke, and other products of combustion. The influence of smoky town air on health is, to some extent, illustrated by the fact that the death-rate of 23 manufacturing towns, selected chiefly for their smoky character, averaged 21·9 per 1,000 in 1880; while the rural districts in the counties of Wilts, Dorset, and Devon, excluding large towns, averaged 17·7 per 1,000; and the deaths from the principal zymotic diseases in the towns were more than double those in the rural districts.

Mr. Aitken, of Edinburgh, has made some very interesting experiments showing that visible fog is due to particles of foreign matter floating in the air. He showed that the vapor of water injected into air from which particles had been strained out, was not visible; whereas, as soon as foreign matter, such as dust, or smoke, or fumes, and especially fumes of sulphur, were introduced, the aqueous vapor condensed on the particles, and became visible as fog. He showed that some kinds of dust have such an affinity for water that they determine the condensation of vapor in unsaturated air, while other kinds of dust only form nuclei when the air is supersaturated; and that dry fogs are produced by those dust particles whose affinity for water vapor enables them to condense vapor in unsaturated air. Among this class of dust may be instanced chloride of sodium or salt, which largely pervades the atmosphere, and is probably derived from sea spray; also ammonia, which is present in town air, and may be largely due to the manure. In towns where the streets are paved with stone, asphalt, or wood, and even where the surface is of macadam composed of granite, the chief part of the mud and dust consists of horse manure, which continually gives off the fumes of ammonia; and this substance, when mixed with fumes of sulphur, has a greater power of condensing aqueous vapor than the products of combustion of pure coal, and gives rise to a very fine-textured dry fog.

The conclusions which may be drawn from these experiments are: 1st, That when water vapor condenses in the atmosphere, it always does so on some solid nucleus; 2d, That the dust particles in the air form the nuclei on which it condenses; 3d, If there was no dust in the air there would be no fogs, no clouds, no mists, and probably no rain; but when the air got into the condition in which rain falls—that is, burdened with supersaturated vapor—it would convert everything on the surface of the earth into a condenser, on which it would deposit itself. Every blade of grass, and every branch of tree would drip with moisture deposited by the passing air; our dresses would become wet and dripping, and umbrellas useless; but our miseries would not end here. The inside of our houses would become wet; the walls and every object in the room would run with moisture. Hence we have in this fine dust a most beautiful illustration of how the little things in this world work great and useful effects in virtue of their numbers. This dust pervades the air everywhere. The haze in the air on a summer's day is caused by dust, which is probably largely composed of the pollen of flowers. This dust appears to occupy the lower strata of air, for in the valleys on the south or Italian side of the Alps a blue haze mellows the view; but this is passed through after a little hill-climbing, and the atmosphere becomes clearer. The theory is not inconsistent with the formation of the loftiest clouds, because dust does not only pervade the lower region of the atmosphere.

Mr. Langley was making observations last autumn on the spectrum of the sun on Mount Whitney, which is within some 300 miles north of the Mexican frontier, and about 200 miles from the Pacific Ocean. When at a height of 13,000 feet above the sea, he observed dust in the atmosphere between him and the sun. He computed that this dust was at a height of 1,000 to 1,500 feet above the elevation at which he was placed; that is to say, at a total height of from 14,000 to 15,000 feet above the sea. It has been suggested that this dust might have been carried by the prevailing winds from the plains composed of loess in China.

There is, however, another source whence dust in the air at higher altitudes may be derived; for recent investigations show that appreciable quantities of meteoric dust are being constantly brought into our atmosphere from interplanetary space. In our towns the dust is more plentiful, but there also it diminishes with elevation. The clumsy and barbarous method which we adopt for burning coal in this country adds to the dust the fumes which necessarily result from combustion, as well as a quantity of soot and tarry matter from the imperfect combustion of coal. Mr. Chandler Roberts, who made experiments on the question of the amount of soot from different forms of grates for the Smoke Abatement Society, found the quantity of soot to vary from about one per cent. in most furnaces, to as much, in some instances, as three per cent. of the fuel consumed in domestic fireplaces; that is to say, the imperfect combustion causes from one to three cwt. of soot for every five tons of coal consumed. This soot assists in forming the black canopy

*Abstracted from the inaugural address by Capt. Douglas Galton, C.B., Hon. D.C.L., F.R.S., etc., etc.; President of the Congress of the Sanitary Institute at Newcastle-upon-Tyne.

which it is fashion in England to consider the proper attribute of a large town.

Dr. Frankland and Dr. Russell have shown that the tarry matter which arises from the combustion of coal coats over the water resulting from the aqueous vapor thus condensed upon the particles of dust, and considerably delays their re-evaporation; consequently, while the atmosphere of large towns is more favorable to the development of fog, the fogs prevailing over large towns are more persistent in their character than in the open country. Moreover, the fumes from combustion contain substances, and especially sulphur, which appear to be more favorable to the formation of fogs than any other form of dust; and therefore, even, if while continuing to burn coal in our towns we get rid of smoke, we should still have products of combustion, which would favor the occurrence of fogs; but they would be fogs of lighter color and less persistency than our ordinary London smoke fog.

The conclusions at which Mr. Aitken has arrived from his experiments are well illustrated by a fact of every day experience. A heavy fall of rain washes the particles of dust out of the air, and after the rain the fog is often removed, and the air of a town is much clearer. But in addition to the chemical and inorganic constituents of air, which have been generally taken as a measure of its purity, recent researches have divulged to us the character of some of its organic impurities

Dr. Tyndall has shown us, by passing a ray of light through a space otherwise dark, that all air is more or less filled with dust; that this dust is destroyed by incineration, and that it is, therefore, chiefly, organic; and his experiments, made with infusions previously freed from all possibility of containing germs in the infusion, or, as he terms it, sterilized, demonstrated that this dust contains germs which are always ready to spring into life when a congenial medium for their development is at hand. He shows that if the air of a room be left absolutely undisturbed for some time, this dust is more rapidly deposited than in moving air. Thus in a sheltered and quiescent position in a room, flasks filled with various infusions developed organisms more rapidly than those placed in the more open parts of the room.

Dr. Tyndall has also shown, by similar experiments, that these sterilized infusions did not develop organisms when exposed to the clear mountain air on the Bel Alp in Switzerland, while the air of a hay-lott near the glacier developed organisms in 90 per cent. of the flasks containing sterilized infusions.

M. Marie Davy, of the Montsouris Observatory of Paris, tells us that the air near to the Hotel Dieu in the center of Paris and near an opening to a sewer, is more prolific in causing the development of bacteria and similar organisms, in prepared sterilized infusions, than air in the more open space near the Montsouris Observatory; and that the latter is more prolific than air on the plateau of Gravelle near Paris. M. Davy also tells us that the air in rainy weather is less prolific in producing bacteria; that it becomes more prolific during the drying up of the rain; but becomes less prolific again in drought and in sunshine. Similarly, the numbers of bacteria are very small in winter; they increase during the spring; attain their maximum in autumn; and then decrease with the rain and cold weather on the approach of winter. The cold of a Parisian winter is inimical to them, and so is dry hot weather, and especially sunshine. It is not alleged that those various organisms are all productive of disease or injurious to the higher forms of life. Some are, no doubt, productive of what we term putrefaction, others may be productive of disease, but some may possibly afford nourishment. It is, however, noteworthy that those observations which show the presence of organisms in certain localities, and in certain conditions of the atmosphere, seem to present coincidences with other observations on the prevalence of certain disease, which at least make it desirable that the inquiries should be further pursued. For instance, in the Punjab the mortality from fever deaths in each of three consecutive years, 1872–73–74, when food was cheap, and when there was no extraordinary occurrence to affect the ordinary relations between fever and rainfall, only began to rise after the rainfall had attained its maximum and had begun to decrease, and the deaths from fever attained their maximum soon after the rainy season came to an end, during the drying up of the ground, after which they decreased. In Bombay the registered fever deaths, on a mean of fourteen years, show a minimum of fever deaths during the hot, bright, and dry season. It is also noteworthy, more especially in hot climates, that those rooms of a house into which sunshine can penetrate are healthy, whereas rooms where no sunshine can penetrate are not healthy.

In our present knowledge, it would be premature to draw any conclusions from these various researches; but they open out an interesting field of inquiry, which is not presumptuous to think may possibly have some bearing on the prevalence of disease. But whatever may be the influence which such organisms or germs exert on the production of zymotic diseases, the sanitarian has attained to the absolute certainty that the number of persons who are attacked by this class of diseases can be increased or diminished in proportion to the defects or the excellence of the hygienic conditions under which they are living.

I have already mentioned to you the effects of sewerage on the mortality of towns. On the general effect of sanitary conditions upon health, the experience of the Indian army is very striking. Periodic fevers occur everywhere in India, and there arise extra vicissitudes of temperature and endemic causes of dangerous disease Yet there, even under these circumstances, sanitary work, by removing preventable causes of disease, has reduced the death-rate of the European army in India from 60 to 1,000, to 16 per 1,000, and is gradually diminishing the death-rate of the civil population.

Perhaps one of the most conclusive examples of the effect of sanitary observances is that furnished by fairs and religious festivals in India. These assemblies bring together many thousands of persons, sometimes even as many as 100,000 persons, together with numerous horses and cattle. They form a huge encampment, lasting for three days, sometimes for weeks. A very few years ago, there was no care taken to prevent the fouling of wells and water-courses, or to regulate the disposal of the refuse which was scattered all over the surface of the ground where this multitude encamped. These fairs and festivals were, therefore, almost invariably foci for the spread of cholera and other diseases. Now this is all changed. Stringent regulations preserve the wells and water-courses from pollution, and compel the people to deposit all refuse in prepared places. All the rest of the ground in the vicinity of the encampment is kept scrupulously clean. Since this has been done, many festivals and fairs have been held in districts where cholera has been prevalent, but yet, owing to these stringent regulations, no cases of cholera have occurred among the persons attending the fairs and festivals. We may find, perhaps, more striking results from the influence of sanitary work in India, or in a tropical climate, than elsewhere; but still we are surrounded by numerous examples of the effect of sanitary work at home.

In the army in Great Britain, the deaths from tubercular disease used to be 10 per 1000—in fact, equal in amount to the total deaths which now occur in the army in peace time. The improvements in the hygienic conditions under which soldiers live, which were introduced into the army in consequence of the recommendation of the Royal Commission on the Sanitary State of the Army and the Barrack and Hospital Commission, have reduced the death-rate from tubercular disease to about 3 per 1,000. This is one of the diseases which it is now alleged can be, or is, propagated by germs; and it is to this point that I desire especially to call attention, viz., that whatever be the manner in which these zymotic diseases are propagated, the death-rate and consequent sickness may be diminished or increased according to the sanitary conditions in which a population lives.

Within limits, it is not the density of population which regulates the health. But if a dense population is spread over the surface, or close to the surface of the ground, by which means all movement of air is prevented, and if there are numerous corners in which refuse is accumulated, it will be difficult to prevent disease. Dr. Angus Smith's experiments show that while there is less oxygen and more carbonic acid in the eastern and in the more crowded parts of London, yet that in open spaces the amount of oxygen rises, and the carbonic acid diminishes very considerably; and that we are exposed to distinct currents of good air in the worst, and equally to currents of bad air in the best atmosphere, in towns like Manchester. Dr. Tyndall showed that while there is quiescence in the air, the tendency of his sterilized infusions to produce organisms was increased. The conclusion from all these experiments is to show the importance of laying out the general plan of dwellings in a town, so that currents of air shall be able to flow on all sides with as little impediment as possible, by which means the air will be continually liable to renewal by purer air.

The dwellings which have been constructed in the place of the very defective dwellings condemned by the medical officers of health, in various parts of London, specially illustrate the importance of this question of the circulation of air. These dwellings replace those in which the normal mortality was as much as thirty-three, forty-four, and fifty per 1,000. But these improved dwellings provide ample space all round the blocks of building, so that air can flow round and through them in every direction, and so that there are no narrow courts and hidden corners for the accumulation of refuse. The mortality in the new dwellings is as low as thirteen per 1,000 in some, and does not rise above twenty per 1,000 in any of them, and upon an average of years it may be taken at from fourteen to sixteen per 1,000.

It is to this point that I specially desire to draw your attention, viz., that these facts prove the possibility of bringing down the death-rate of the class of population which inhabits this sort of accommodation to rates varying from fifteen to sixteen per 1,000. I say of the class of population, because habits and mode of life have an important influence on health and on longevity.

We have done much for the health of young people by the Factory Acts, in regulating their labor; and we have made stringent rules to compel their attendance at school, but in these latter regulations it is to be feared that the health of the children has been too little considered. Mr. Chadwick and Dr. Richardson have long pressed upon the consideration of the public the defects of the elementary school system, first, as to the insanitary conditions of the rooms in which most of the school work is performed, and secondly, as to the advantages which have been found to result from making physical training a portion ofordinary school work. Dr. Richardson shows that the long hours spent in school do not produce results commensurate with their length. That is to say, he shows that in those schools where half the time is allotted to physical training, the children learn quite as much as in schools where the whole time is devoted to study; that the children are brighter, and that they are eventually turned out of the school better qualified to take up the avocations of daily life.

On the other hand, the condition of the children is an important factor in the ventilation of a school-room. With children who are not washed all over daily, the skin and the clothes assist in producing a foul atmosphere: and the rooms crowded with children in that condition require special means of ventilation Unless this is provided the atmosphere is injurious. But, as a rule, the children are not thoroughly washed every day, nor are exceptional means of ventilation provided. From some recent statistics, it appears that the death-rate of elementary school teachers amounts to as much as twenty per 1,000, which is more than double that of soldiers on home service, and about four times that of the police or of sailors, in which forces, apart from deaths from accident or violence incurred in their profession, it amounts to about five per 1,000. It is even from five, six, to seven times greater than that of those criminals who are imprisoned who have no specific disease, among whom, when they enter a well-conditioned prison, the death-rate does not exceed three per 1,000. The sickness will be proportioned to the death-rates; and there can be no question but that the high death-rate is largel due to the unhealthy atmosphere in which their work is performed.

Dr. Carpenter says, in his work on "Human Physiology," that the "purity of the atmosphere habitually respired is essential to the maintenance of that power of resisting disease which, even more than the ordinary state of health, is a measure of the real vigor of the system. For, owing to the extraordinary capability which the human body possesses of accommodating itself to circumstances, it not unfrequently happens that individuals continue for years to breathe a most unwholesome atmosphere without apparently suffering from it; and thus, when they at last succumb to some epidemic disease, their death is attributed solely to the latter, the previous preparation of their bodies for the reception and development of the zymotic poison being altogether overlooked."

It is not so many years ago that the death-rate of the army at home nearly equaled that now prevailing among the elementary school teachers. The large army death-rate was shown to arise from defective ventilation and want of other sanitary arrangements. These were remedied, and the army death-rate was reduced to from eight to eleven per 1,000; and there can be no doubt that if the 'same care were bestowed upon the purity of air in and around our school-rooms, as is bestowed upon our barrack-rooms and prison-cells, the health of school-teachers and of the children would be materially benefited.

The following extract from a paper by Mr. Chadwick sums up this experience: "In one orphan institution the progress made by the application of sanitary factors was thus denoted. The death-rate among the children was twelve in 1,000. The impurity of the air was removed by better drainage, and the death-rate reduced to eight in 1,000. A further advance was made by regular head-to-foot ablutions of the children with tepid water, and a complete skin cleanliness maintained, when the death-rate was reduced to four in 1,000. In the district half time schools, near London, where the sanitation is the best advanced, they receive children of the lowest condition and type, and may be said to be children's hospitals; but of those who come in without any developed disease, the death-rates from disease of spontaneous origin do not exceed three in 1,000, or one-third of those of children in the board or common schools. I deduce from experience that skin cleanliness and clothes cleanliness is a factor of prevention of the common death-rates among dirty children, in crowds or in schools, by one-third."

Mr. Chadwick further dwells on the economy of cleanliness. He states that it has been ascertained that pigs that are washed put on one-fourth more flesh from the same quantity of food than do pigs that are unwashed. The food that would be required for four children that are unwashed would serve for five children that are washed. A general whose army was hemmed in and put upon short rations encouraged his men to bathe daily; he said that by that means he kept his men in as good condition and force as another division of the army that was on full rations, but unwashed. I am informed by colliery proprietors that horses in a colliery which are well groomed do more work and look better than badly groomed horses with an equal amount of food. And there is a German proverb which may be translated: "Well washed is half the feeding."

My object in presenting to you these facts is to show you that you must not be satisfied with an average death-rate in your towns of 21·8 per 1,000, but that you should investigate the death-rate in each part of your town, and in each class of your population at several ages, and ascertain where it is in excess, and what are the causes of the excess, and then do your utmost to remove those causes. For the death-rate is an indication of the degree of wasted force in the country. Let us consider for a moment the losses to the country which are evidence by a high death-rate. Take a professional man who has accumulated a large amount of knowledge, and what is better, of experience; or take an artisan who is a skillful craftsman. They die in the prime of life, when they are most fitted to use these qualities; the knowledge, experience, and skill which have required many years and much labor and expense to accumulate, all go with them, before the crop of usefulness, in the cultivation of which so much has been expended, has ripened and been gathered. But there is also to be considered the loss by sickness. The death-rate affords, to some extent, an index of the disease-rate in the community. It is, however, very difficult to ascertain, with any degree of accuracy, the disease-rate of a community, as compared with the death-rate. If we take the army as a criterion, it would seem that there are more than 100 men admitted to hospital to one death, while the number constantly sick averages from four to six times the number of deaths. No doubt, in the army, many an ailment has to be treated in hospital which in ordinary life would allow the sufferer still to pursue his vocations

The sickness of the population is not registered, and it is very difficult to obtain any data respecting it. It has been generally stated that there are on an average twenty cases of sickness to one of death, of which four out or five are of children. I find, however, from a return of an unsanitary district in St. George's-in-the-East, that with a death-rate of thirty-one per 1,000, the sickness rate was 270 per 1,000, or nine cases of sickness to one death. But in the worst parts of the same district the sickness-rate amounted to 620 per 1,000, which gives twenty cases of sickness to one death.

Mr. Neison, who has recently examined the records of the Ancient Order of Foresters, shows that at thirty-five years of age there are, on an average, twenty-two cases of sickness to one death, and that is in a body of men which, it must be borne in mind, are selected men as far as health is concerned. From the same record, we find that, at twenty years of age, the loss of time from sickness amounts to 1·5 per cent. of the whole time; and at forty years of age it amounts to 2·6 per cent. The value of a single premium paid at twenty years old (calculated on the 3 per cent. table), to £1 a week during sickness, for the whole life, is £40. I sought, but failed to obtain, definite statistics on this subject from some of those who are working among the poor, both in the east and west end of London. An east end clergyman remarked that "the poor go on living wonderfully in wretched places, but that they have so much ill-health. They are perpetually on the trudge to the hospitals with their bad chests and bad legs, and get patched up again and again, and live on."

Our London hospitals and dispensaries cost, according to Mr. Burdett's statistics, nearly £690,000 annually to administer. The average number of out-patients treated at the various institutions in a year is about £1,000,000—that is to say, more than one out of every four inhabitants of the metropolis becomes an out-patient in the course of the year. This expenditure is incurred mainly for the purpose of patching up the wretched poor, who have been injured by bad drainage, want of ventilation, darkness, etc. Though drink may be one of the immediate causes of many hospital cases, yet the tendency to drink is created and fostered by the wretched dwellings of the very poor. But besides the time lost by the sickness itself, there is the large amount of time wasted by the poor in going to and waiting at hospitals, which would be spent by healthy poor in labor. There is, moreover, the great amount of lassitude and idleness in the low-class poor, which Dr. Richardson traces to want of ventilation, in their own and former generations.

I think we may safely assume that if we can, by preventive arrangements, bring down the death-rate of the wage class to the standard afforded in good sanitation, you would reduce the sickness rate in a similar proportion at least. By means of this item alone the wage earning power of the industrious classes would be enlarged by some millions of pounds, and their comfort correspondingly increased. You would effect, in addition to the savings under this head, certain other distinct economies. For instance, it is certain that the need for much of the accommodation in our prisons, reformatories, and workhouses arises from evils incident to unhealthy circumstances and crowded dwellings.

We shall probably be led to appreciate more fully the advantages of good sanitation, if we can arrive at putting a money value upon some of the results of sanitary improvements. In the first place, the community derives a direct advantage from adopting such a system for the removal of refuse as will enable it to be applied directly to improving the cultivation of land. For while, on the one hand, the

rapid removal of refuse from the neighborhood of dwellings by the efficient sewering of towns results in improved health, the application of sewage to land by the irrigation of growing crops affords both a means of fertilizing the land, and of cleansing the fluid, so as to place it in a fit condition to pass into the streams. My friend, Mr. Chadwick, asserts that where the sewage is undiluted with rain-water, and where it is utilized at once, and carefully applied under favorable conditions, an acre of land ought to absorb the sewage of a hundred persons, and that the crops on this area should feed five cows; or, if put in another way, that the produce of ordinary cultivation being represented by one, and market-garden produce by three and a-half, the produce of sewage cultivation should be represented by five. I have obtained some recent facts on the direct application of sewage to land, which, although they do not show such high results, deserve attention.

Mr. Brundell, who has the management of the Doncaster Sewage Farm, states that during nine years he has never applied any other manure than sewage. That this year the crops are the heaviest that have been produced, and the land remains just as capable of receiving the sewage as it ever was, and does not "tire." Mr. Collett, of the Bedford Farm, says that their produce is generally much above the average of the neighborhood, and that the crops are as good or better than they were seven or eight years ago; and the land under sewage treatment has improved in quality.

Mr. Champion informs me that at Reading, with sewage irrigation, they cut the Italian rye grass six and seven times in the season, as compared with two crops without sewage; that mangolds grown with sewage produce from fifteen to twenty tons per acre more than when grown in the usual way; that their oat crop this year yielded from fourteen to fifteen quarters per acre, the straw being from seven to eight feet high, and remarkably stout and stiff.

Colonel Jones, of Wrexham, tells me that "having farmed many hundred acres during the last three years for the landowners who had farms thrown on their hands, I have had some opportunity of comparing actual results of farming, with and without the resource to be derived from a town sewer, and I have no hesitation in saying that produce may easily be doubled per acre by the proper use of sewage as regards any crop, and that four or five times the weight of grass is a certainty in any season; and it is simply a question of management and market, whether or not a sewage farm can be made to pay."

There are occasionally, no doubt, difficulties to be overcome in the application of sewage to land, and some eminent advocates of the conversion of sewage into manure have said that if the sea is at hand it is better to throw sewage into the sea than to utilize it. But that is not the language used in speaking of the manure of an ordinary farm; yet the one is, in its way, and under its own conditions of use, as valuable for improving crops as the other. Farmers say that one of the best ways of obtaining manure for the land is not to buy artificial manure, but to buy oil cake or other suitable food, and to feed sheep and cattle upon that; and land is largely manured by means of oil cake and Indian corn imported from abroad as food for domestic animals. A recent investigation showed that one third of the food which is consumed by the people of this country comes from abroad; and, therefore, if we applied the sewage of our population to our land, we should enrich the land by the millions of quarters of foreign corn and the thousands of tons of foreign meat which are imported and consumed in the country; and, so far from the land of England deteriorating under such conditions, it ought to become richer, year by year, by these enormous importations of food. Therefore, whatever may be the trouble and expense in individual cases of applying the sewage to the land, the application, so far as the interests of the community are concerned, must add to the stored-up wealth of the country. In the next place, the diminished death and sickness rates, and the greater length of life entailed by good sanitation, afford direct pecuniary advantages.

Let us apply this reasoning to the population of the Improved Artisans' Dwellings in London. These now accommodate about 11,000 families. In many of the districts which are now covered by these improved dwellings, the death-rate in the wretched homes which have been removed varied, as I have told you, from thirty to forty and even fifty per 1,000. Mr. Gatliff shows that there are nearly five in a family on an average in model-lodging houses. There has thus been a saving of life, to the extent of at least twenty per 1,000, by the erection of these dwellings, on the 50,000 persons inhabiting them, or about 1,000 deaths annually. And if we take the estimate of sickness which I arrived at above, there would be a reduction in the number of cases of sickness which occur in the population of these dwellings of at least from 15,000 to 20,000. The cost of the improved dwellings appears to have averaged a little over £170 each, or about £1,900,000 for the 11,000 families.

By the light of these various data we may obtain some idea of the actual pecuniary advantage to the community which results from the improved health of the occupants of such dwellings. The cost of funerals has been stated to average £5 a piece. Under this head, therefore, the saving may be taken to average £5,000 a-year; the diminished loss of the sickness of the 11,000 heads of families alone may be assumed to average another £5,000 a-year; and in addition to this there would be the saving in time and money, in seeking medical attendance, of the wives and children who make up the remaining population of the dwellings, as well as the increased power of earning wages afforded to the mothers of families from the diminished sickness of the children. Hence the money benefit to the community thus made up, which is caused by the diminished death-rate and sickness-rate, would form an appreciable item in the percentage of interest paid on the £1,900,000 capital expended in the construction of the dwellings.

But there is another way in which we may estimate the economy to the community resulting from the increased health which has been obtained in these dwellings. The analysis of the mortuary rates for Westminster showed that the mean age at death of the males of the wage classes in Westminster, who had survived the period of youth, and died after twenty, was 47·6 years. The rate of mortality in the improved dwellings is from fourteen to sixteen per 1,000. The rate of mortality in the rural parishes of Northumberland in the years 1877–81, was 15·3 per 1,000; and in Dover in 1880, it was 18·7 per 1,000. It will not be unfair therefore to take the mean age at death of the males who died over twenty in the rural parishes of Northumberland and in Dover as a standard which may be reasonably expected for the duration of life of the males who die over twenty years of age in the improved dwellings. This was, for the rural parishes of Northumberland, 60·9 years, and for Dover it was 57·8 years. That is to say, from 10·2 to 12·3 years, or a mean of 11 years additional duration of life may be expected for the heads of families occupying the improved dwellings, beyond that enjoyed by the wage classes who do not live in such favorable surroundings.

Therefore we may assume as a profit to the community the increased earning power of the occupants of these dwellings, due to this increased expectation of life. It would appear, from Mr. Neison's tables, that 6 per cent. would be a full average deduction for sick time between forty-seven and fifty-eight years of age; and we may therefore safely take the increased earning power as that due to an additional 10·4 years of life. If, in order to form a rough estimate of the money value of this, we assume that each of the heads of the 11,000 families receives as a present on his admission to the dwellings a grant of ten years more life, and calculate its money value on the earnings of only £1 a week, we find that upon a 4 per cent. table the present value of ten years of increased wage-earning power, at £1 per week, would be, for 11,000 heads of families, £4,640,000, or nearly two and a half times the cost of the property. By considering the question in this way, we arrive at an understanding of some of the direct pecuniary advantages which accrue to the nation from those sanitary improvements which lead to a decreased death-rate and sickness-rate; and we see that, however large may be the cost of the removal of bad dwellings, and the substitution in their place of healthy well-planned dwellings, the actual money gain to the community far exceeds the expenditure in money. But it is not as a money saving alone that the question must be considered. Its social and political bearings are even more important. The nation is made up of individual items. The goodness and the happiness of the nation depend upon the individual. Well-regulated family life does more to make up individual happiness than any other form of life. But family life is impossible in the wretched homes which have been permitted to exist in most of our large towns and many of our rural parishes. These wretched homes drive the population into the streets and into the gin palaces and into the public houses. They engender sickness, which entails poverty, and they foster crime. The improved dwellings, on the other hand, insure improved health; and by thus affording a security for the more continuous earning of wages, create the possibility of a comfortable home. I was much struck, when in the United States of America, with the fact that the artisan and wage classes, in many manufacturing towns, lived in very comfortable houses, in which each family had their parlor with appropriate furniture, pictures, and often their piano. They had come to look upon these things as a necessity; and this is an evidence of the general civilization which pervades American society. By civilization, I mean the education and the general well-being of all classes. In this country, our most advanced sanitarians have long endeavored to impress these doctrines on the public, and I am happy to think that at last they are beginning to bear some fruit; for, in order to develop morality, contentment, and happiness among a people, it is essential that they should be provided with healthy and comfortable homes.

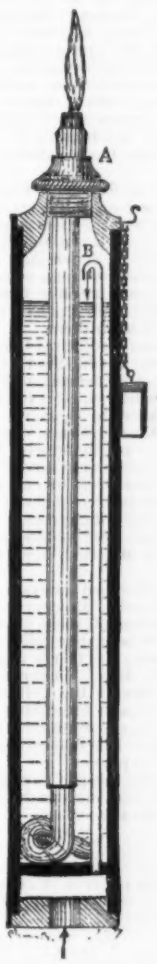
NEW TEST FOR ALBUMEN.

By WM. ROBERTS, M.D., F.R.S., Physician to the Manchester Royal Infirmary.

WHEN an albuminous urine is treated with a saturated solution of common salt, not the slightest reaction takes place; but if the brine be slightly acidulated with hydrochloric acid the albumen is thrown down as a dense white cloud. This reaction constitutes a most delicate test for albumen in the urine. The best degree of acidulation for this purpose is obtained with about 5 per cent of the dilute hydrochloric acid of the pharmacopœia. A little more or a little less acid makes no appreciable difference in the sensitiveness of the test. Common salt dissolves in about two and a half times its weight of water at 60° F., and increase of temperature does not sensibly increase its solubility. The salt of commerce is always more or less dirty, and the solution requires filtration to fit it for use as a test. The salt solution should be fully saturated, otherwise the observer is apt to be led into error. In preparing the test with our common English measures, the readiest plan is to mix a fluid ounce of dilute hydrochloric acid with a pint of water, and to saturate this with common salt, and filter. Dilute hydrochloric acid may be replaced by dilute sulphuric, dilute nitric, or dilute phosphoric acid. All these acids are of the same saturating strength in the British Pharmacopœia, and all of them yield with saturated salt solution an equally sensitive reagent for albumen. Even acetic acid may be used, but the delicacy of the test in that case is not quite so great as when it is prepared with one of the mineral acids. The method of applying the brine test is similar to that followed with nitric acid. A portion of the suspected urine is placed in a test tube, the test tube is then held very much aslant, and the salt solution is allowed to trickle along the sides of the tube to the bottom, so that it may form a distinct layer below the urine. If albumen be present, a white cloudy zone appears at the junction of the two fluids. Or, the proceeding may be reversed. The salt solution may be first introduced into the test tube, and then the urine added with the same precautions as before, so as to obtain two distinct layers, one above the other, in the test tube. It is important to be aware that the precipitation of albumen by acidulated brine is not due to a true coagulation. In this respect the brine test differs from nitric acid and boiling. In the two latter cases the albumen is transformed into the insoluble modification, which is known as "coagulated albumen." But when albumen is thrown down from urine by acidulated brine, the precipitate is not insoluble; on the contrary, it is redissolved by free addition of water, or even by free addition of the albuminous urine itself. It is therefore essential to the efficient application of the test that the salt solution should be in excess at the point of expected reaction. This end is obviously secured in the above described methods of testing. It may also be secured by adding to the suspected urine a volume of the salt solution at least equal to that of the urine in the test tube. If this point be not attended to, the test is unreliable. For instance, if acidulated brine be added, drop by drop, to an albuminous urine, and the mixture shaken up after each addition, the first few drops either occasion no turbidity whatsoever, or the turbidity produced disappears on shaking. But when, by successive additions, the quantity of brine approaches to or surpasses the volume of urine operated on, the turbidity remains permanent. In point of delicacy the salt test stands on a par with nitric acid. The minutest trace of albumen detectable in the urine by nitric acid is also detectable with equal ease by acidulated brine. In high colored urines the brine test is distinctly superior. In this class of urines nitric acid produces a deepening of the tint, with, often, a disengagement of gas, which interferes with the sensitiveness of the reaction, but the brine test neither alters the tint nor causes disengagement of gas. On the other hand, I think that nitric acid gives a better idea of the quantity of albumen present by the density of the white cloud produced than does the brine test. In addition to albumen, acidulated brine precipitates peptones, which are sometimes present in urine; so that occasionally a slight cloudiness is produced by the salt solution where nitric acid and boiling (which do not precipitate peptones) produce no reaction. This distinction in the action of the brine test may hereafter lead to interesting information. In dense urines, highly charged with urates (but not containing albumen), the addition of nitric acid sometimes throws down the amorphous urates in the form of thick white clouds, and it is necessary to apply heat to distinguish with certainty the cloudiness so produced from cloudiness due to albumen. The salt test does not throw down the urates in this way. It is well known that the urines of patients who are taking large doses of resinous substances (such as the resin of copaiba), although free from albumen, yield a cloudiness with nitric acid in the cold, but if the urine be previously made hot, nitric acid produces no such reaction. This difference serves to distinguish cloudiness due to resin from cloudiness due to albumen. The brine test also produces a cloudiness in resinous urines, and the reaction occurs whether the urine be hot or cold. To avoid the fallacy thereby arising, all that is necessary is to add an excess of the urine which is being tested. If the cloudiness be due to albumen, it disappears on such addition, but if it be due to resin, the cloudiness does not disappear on the addition of more urine. One of the chief advantages of the salt test is its incorrosive character. It does not stain nor burn holes in garments and carpets, nor fleck the hands with yellow spots. The use of it makes it possible to arrange a pocket case for urine testing that shall not be a terror to the wearer. From this point of view the substitution of the salt solution for nitric acid will be a real boon to practitioners.* The salt test has this additional convenience—that it enables us to test successively for albumen and sugar on one and the same sample of urine. The suspected urine is first tested for albumen with the salt solution, and then Fehling's solution, or, still better, a pellet of the solid Fehling's test, sent out by Cooper, is added, and heat applied. After boiling a few seconds, the absence or presence of sugar is ascertained. The admixture of the brine in no way interferes with the copper reaction, in case sugar should exist in the urine.—*Lancet.*

LIGHTING BY BENZINE.

MANY experiments have been made, without much success hitherto, with a view to finding some cheap, pure, and



LIGHTING BY BENZINE.

smokeless light as a substitute for candles for domestic purposes. Ordinary colza oil or kerosene lamps cannot in all cases serve as a substitute for candles, as they require the use of a glass chimney and cannot be placed in an inclined position. Benzine, which is one of the most volatile of the hydrocarbons furnished by the distillation of petroleum, has not the same disadvantages. It burns absolutely without smoke, but its extreme volatility at ordinary temperatures

* I have carried about with me for some months past a little pocket case (which is only a stiff-backed cigar case) which I have found a useful and safe clinical companion. It contains a book of litmus papers; a narrow corked phial filled with acidulated brine; a test tube charged with Cooper's pellets of the solid Fehling's test, guarded with an India-rubber stopper; and, lastly, an empty test tube, also provided with a cork. This compact arrangement furnishes the means of ascertaining the reaction of the urine, and of testing it in the most delicate manner for albumen and sugar. The empty test tube also serves to carry home a specimen of the urine for further and more minute examination. The "pellets" (made after a suggestion of Dr. Pavy) are sent out by W. T. Cooper, chemist, 26 Oxford street, London.

makes it impossible to use it in the lamps ordinarily in use. This difficulty has been surmounted by means of a small apparatus constructed by the Gaggenan Iron Works, England, and shown in the accompanying cut, borrowed from the *Mechanical World*. It consists of an iron tube, in the form of a candle, containing benzine. The wick is inclosed in a tube which runs nearly to the bottom of the reservoir. When the candle is inverted the liquid cannot escape through the wick tube. It is well, however, not to put in so much benzine as indicated in the cut; it will be sufficient to merely half fill the apparatus. Under such circumstances the candle may be inclined at any angle without inconvenience. The extremity of the wick is made of asbestos, so that it will last. The products of combustion are odorless, and no more injurious than those given off by stearine. There is no danger of explosion, since there is never any communication between the flame and the space above the liquid. The admission of the air necessary to keep up an equilibrium of pressure between the exterior and interior is effected through the small tube, B, which is fixed in the false bottom of the apparatus and communicates with the atmosphere through a hole in the bottom properly so called. If the vapor of benzine which flows above the liquid reaches a pressure above that of the atmosphere it escapes through the tube, B, at a sufficient distance from the flame to prevent any danger. At the side of the apparatus there is an extinguisher suspended from a small chain.

This apparatus may be used in various ways; it may be carried in the hand, be placed in a chandelier, be screwed directly to a flat disk, etc., etc.

[We advise that all the benzine be omitted. It is rather more dangerous than gunpowder, as its vapor has a way of traveling toward fire and then exploding, whereas gunpowder remains where it is placed until fire comes to it.—EDS. S. A.]

MALT CAKE.

MANY of our readers still remember the time in which the great swine slaughter-houses of this place threw away the heads of swine as wholly worthless, and the streets were filled up with them; something similar happened in other establishments; a great quantity of material, which to-day is regarded as very valuable, was thrown away as entirely useless.

In the breweries, for example, no value was placed upon the malt thicket, that is, malt boiled and used, and the owners of breweries were glad to have people take it away.

Within the last few years this malt thicket has first been known and used as a valuable article of food. From the nature of the case this malt thicket could not long be preserved in its moist condition, nor protected against souring, nor transported any distance. But the Messrs. Uihlein, after much thought, have succeeded in finding a way to overcome this difficulty, and to make out of this malt thicket a food, particularly for milch cows, whose value is very important and which from present indications will soon constitute a new article of trade.

In the interest of farmers who pursue dairies, and indeed of all those who keep milch cows, we give here a further description of the new food material, together with the chemical analysis.

The malt thicket, as it comes from the so-called fine mash vat, is, after being slightly dried, mixed with a certain material as a cement, and then in a machine peculiarly constructed for the purpose is pressed into cakes resembling linseed cakes, one inch thick, ten inches wide, twelve inches long, which, when ready, weigh a pound.

The cakes smell somewhat like fresh baked bread, that is very agreeable, and swell up like a sponge as soon as warm water is poured upon them.

One cake is abundantly sufficient to furnish a good pail of excellent drink. That this food is very readily assimilated; that it must produce an important effect upon the secretion of milk, and, consequently, is exceedingly valuable for milch cows, can easily be perceived from the analysis. Because of their slight weight and dry character, these are readily transportable, are in no wise affected by climatic condition; can as well be sent across the sea to the East Indies and South America as to our suburb, Wauwatosa. The price of the cakes per ton of 2,000 pounds amounts to from $12 to $14—a very trifling cost.

The inquiry for this food is already very considerable, and in a few days the Messrs. Uihlein will conclude a contract with Liverpool.

Before giving the chemical analysis, we will remark that the Jos. Schlitz Brewing Company has already filed a patent for the production of their food. The analysis was undertaken at the Philadelphia College of Pharmacy, No. 145 North Tenth Street, and thence reported as follows:

Eugene Wurthoff, Esq.: Yesterday I completed the analysis, and as I came to the College, I found your dispatch in which you inquire concerning the same. I made a double analysis, the exact result of which I herewith give you. At the same time I inclose an analysis of the different kinds of grain, for comparison.

From this it is evident that it is rich in albumen, that it contains more potash than most grain, and that it has nearly the nutritive value of oats.

COMPARATIVE ANALYSIS.

	Moisture.	Albumen.	Fat.	Sugar and Starch.	Woody Fiber.	Potash.	Value per lb., in cents.
Wheat, kernel....	13·56	12·42	1·70	67·89	2·66	1·77	3·77
" meal.....	13·18	11·27	1 22	73·65	0·84	0·84	3·70
Rye	15·26	11·43	1·71	67·82	2 01	1·77	3·71
Barley	13·78	11·16	3·12	65 51	4·80	2·63	3·50
Oats.....	12·92	11·73	6·04	55·43	10·83	3·05	3·50
Oatmeal.....	10·05	14·29	5·65	65·73	2·24	2·02	4·17
Corn	13·88	10·05	4·86	66·78	2·84	1·69	3·51
Buckwheat.....	11·36	10.58	2·79	35·74	16·52	2·91	3·22
Schlitz food cake.	13·67	13·88	5·18	54·21	7 07	4·70	3·77

According to these statements, it is indeed to be assumed that this food will become an important article of trade. The Jos. Schlitz Brewing Co., through the invention of this food, has made itself deserving of much credit as to agriculture.—*Translated from the Milwaukee Banner and Volksfreund.*

THE INK-BAG OF THE CEPHALOPODA.

THE researches of M. Paul Girod upon a great number of Cephalopods of the North Sea and the Mediterranean, researches carried on in several successive sojourns at Roscoff and Banyuls, have elucidated many points in the anatomy, physiology, and development of the ink-bag of those mollusks. The ink-bag is a long, black, pyriform sac opening at the summit of a papilla upon the posterior lip of the anus, and consists of a large reservoir, and of an ink-gland attached to the posterior face of the reservoir, and communicating with it by means of a small round orifice at its upper part. This description differs from that of preceding naturalists, whose statements are to the effect that the secretory apparatus consists of a reservoir whose walls are thrown into folds circumscribing spaces which pour the products of secretion directly into it. In the decapods the gland is free and projects into the ink-sac, but in the octopods the walls of the glands are united for much of their extent with the wall of the reservoir.

Ink-sac and gland are inclosed in a common envelope, consisting of an external tunic of conjunctive tissue; a middle tunic composed of a bed of smooth transverse muscular fibers crossed by a layer of horizontal fibers, and succeeded by a layer of pigment cells; and an internal tunic constituting the special membranes of the gland and reservoir. At the mouth of the sac is a terminal ampulla, bounded at each end by a thickening of the conjunctive tissue of the wall of the sac with a corresponding ring of muscular fibers from the transverse layer, thus forming a double sphincter.

The ink-sac is lined with pigmented pavement epithelium, except the terminal ampulla, which is lined with cylindrical epithelium similar to that of the epidermis of cephalopods.

The gland is composed of undulating lamellæ, leaving between them spaces of variable form. These lamellæ, flat near the orifice of the gland, become concave as they recede from it, and thus form concentric cups enveloping a central whitish mass (formative zone), and becoming of a more vivid black as they are more distant from the center. Analysis of the black secretion proves it to consist of 60 parts of water, 30·5 parts of organic insoluble matters, a little less than one part of soluble organic matters, and 8·6 parts of soluble and insoluble mineral substances. Among the soluble inorganic matters are carbonic acid and the sulphates and chlorides of sodium, potassium, magnesium, and lime, while among the insoluble matters are carbonate of lime, magnesia, and peroxide of iron. Iron and copper are both present in the blood of the Cephalopoda, the latter metal as a component of hemocyanine, which plays in these creatures the role of hemoglobine in vertebrates. In the soluble organic matters neither urine, uric acid, xanthine, nor guanine can be detected, so that the gland is proved not to be a depuratory urinary organ. The greatest portion of the black pigment consists of an insoluble organic matter to which Bizzio has given the name of *melaine*, and the composition of which greatly resembles that of the pigment of vertebrates.

At the thirteenth day of the development of a cephalopod the anal invagination forms. This increases and divides into the ink-bag and rectum. The cellules at the blind extremity of the growing ink-bag multiply and form a thickening which is the commencement of the ink-gland. The study of the tissues and development of the ink-bag proves that the epithelium of ink-sac and gland is a continuation of the epidermis, and that the wall of the bag is a cutaneous fold.

M. H. de Lacaze-Duthiers has discovered and described in the gasteropods a gland secreting a pigment and having the strictest relations with the rectum, opening into the anus and closely applied to the end of the digestive tube. This anal gland is in relation to another gland (*glande pupurigène*) supplied at once with venous blood, and with venous blood that has passed through the renal body. A gland with a vascular distribution identical with the latter gland of the gasteropods, and with similar nervous connections, has been discovered in the cephalopods between the ink-bag and the gills, and thus M. Girod is impelled to admit the homology of the anal gland of the gasteropods with the ink-bag of the cephalopods.—*American Naturalist.*

THE PRESENT CONDITION OF EPHESUS.

THE remains of Ephesus were visited on September 23 by Mr. J. Russell Endean, who gives the following description of the state of the ruins:

Emerging from the station we saw immediately on the left hand the standing ruined columns that supported the aqueduct which once supplied the city with water. Unlike the columns in Rome, which may still be seen in many places bearing the aqueduct, these columns have nothing but broken fragments of arches still attached to them. Hence we proceeded over very dusty roads and through maize fields to the Magnesian Gate, passing on the route many excavated and ruined tombs, broken sarcophagi, etc., with a vast amount of *debris* everywhere, covering Mount Prion on our right, the Tomb of Androcles, etc. In the Gymnasium some ruined columns and arches still testify to their former grandeur. Before reaching the Odeum Theater we saw the tomb reported to be St. Luke's. This is in a greatly more ruinous condition that when last photographed, and, unless quickly protected, the remaining vestiges taken to prove its identity will rapidly disappear. The one sculptured marble slab now perfect is lying half prostrate on the rubbish beneath it, and an unlucky fall of a stone upon it would, most probably, break this beautiful slab to pieces.

The site of the Odeum is covered with *debris*, with large blocks of white marble, beautifully sculptured, lying scattered over its surface. The Theater is in a similar state. On the way to the Stadium we passed over the site of the Gymnasium, over a roadway said to have been formerly the covered way of the market-place, fragments of the mosaic pavements lying beneath our feet. The Stadium is an extensive ruin, with parts of broken columns after the style of the Roman Forum still standing.

Now leaving Mount Prion on the right, we proceeded through fields of standing maize to the Temple of Diana, that temple described by Murray as "the most magnificent in the world." Here we had anticipated seeing some noble evidences still standing of its former grandeur, but we found nothing but the most absolute and complete ruin; the whole site was covered with nothing but rubbish and small broken fragments of marble, many pieces being proofs of the exquisite workmanship expended upon the temple; but of the original structure it may truly be said there is not left one stone standing upon another.

The Church of St. John, the Castle on the Hill, and the ruined mosques are gradually falling more and more into decay, and if they are to be preserved the effort to preserve them cannot too soon be made. Taking the site and surroundings of the city, for situation nothing can well be conceived more beautiful; but now the eye must rest upon the scene in order to realize how utter and absolute the ruin is of this once great center of Asiatic splendor and magnificence. If the Christian world desire to preserve what is yet standing in Ephesus, it is of the first importance that prompt steps should be taken in order to protect what is yet left so worthy of protection, or otherwise the little that remains will sooner or later be removed or destroyed.

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